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A REPORT ON POLLUTION IN THE MIDDLE REACH OF THE SAVANNAH RIVER, GEORGIA-SOUTH CAROLINA

Environmental Protection Agency
Athens, Georgia

August 1971

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Environmental Protection Agency
Southeast Water Laboratory
Technical Services Program
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INTRODUCTION

A Water quality survey of the Savannah River from seven miles north of Augusta, Georgia to approximately seventy-five miles southeast of Augusta, was conducted during July-August 1970. The survey included the identification of waste sources and water quality in the main stem and major tributary streams in both Georgia and South Carolina. Water quality on tributary streams within the AEC Savannah River Plant area was examined during October 1970.

This survey was requested by the Georgia Water Quality Control Board and concurred with by the South Carolina Pollution Control Authority. Extensive assistance was provided by both agencies during the planning and operations phases of this project. Full cooperation was received from the Atomic Energy Commission, as well as the numerous municipal and industrial entities examined. The Savannah District of the U. S. Army Corps of Engineers provided valuable information on the hydrological characteristics of the Savannah River. The successful completion of this report could not have been accomplished without the contributions of these agencies, and their assistance is gratefully appreciated and acknowledged.

SUMMARY AND CONCLUSIONS

Summary

The Georgia fecal coliform bacteria criteria of 5,000/100 ml was exceeded from just north of the City of Augusta and Hawks Gully outfalls to downstream of Spirit Creek, a distance of 18 miles. Except for locations upstream from all waste sources, pathogenic Salmonella were isolated at all Savannah River stations in the 74 mile reach sampled.

Dissolved oxygen below 5.0 mg/l was not detected in the Savannah River during the period of this study; however, a diurnal study of dissolved oxygen showed that wastes originating in the reach of the river between Hawks Gully and Horse Creek were of sufficient magnitude to noticeably reduce the oxygen assets of the Savannah River.

1. The Savannah River, middle reach, receives daily wastes with a 5-day Biochemical Oxygen Demand (BOD_5) of 73,200 pounds. These wastes are equivalent to the untreated wastes discharged by a human population of 439,000. Sixty-one percent of the waste loads measured are from Georgia sources. The remaining 39 percent are from sources located in South Carolina.
2. The major sources of wastes originating in Georgia enter the Savannah River from the City of Augusta, Columbia Nitrogen Corporation, Olin Mathieson Corporation, and grossly polluted flow from Butler Creek, Hawks Gully and Spirit Creek.
3. It is estimated that only 30 percent of the total water supply for the Augusta, Georgia, area reaches the treatment system. Approximately eight million gallons per day (MGD) of wastes are routed through the Augusta sewage treatment plant, a primary facility, with BOD_5 removal efficiencies less than 40 percent.

4. Columbia Nitrogen Corporation Caprolactam Plant discharges approximately 3,000 pounds per day of BOD_5 directly to the Savannah River. This waste exhibits toxic or growth inhibiting characteristics. A total nitrogen load of 3,700 pounds is also discharged daily to Beaverdam Ditch from the nitrogen plant.
5. Olin Corporation has reduced its mercury discharge from 12 pounds per day to less than a quarter of a pound per day.
6. Mean fecal coliform bacteria density in Hawks Gully outlet was 20,000/100 ml, and Salmonella organisms, which are pathogenic to man and other warm-blooded animals, were isolated
7. Butler Creek, at the confluence with the Savannah River, contained an average dissolved oxygen of 0.5 mg/l, BOD_5 of 47.9 mg/l, and fecal coliform bacteria density of 5,900,000/100 ml.
8. Indirect drainage to Butler Creek from Camille Ditch, Rocky Creek, Gwinnett Street Ditch, and Oats Creek contained dissolved oxygen concentrations of zero, 1.4, zero, and 4.0 mg/l respectively. The upper reach of Beaverdam Ditch, a tributary to Butler Creek, has undetectable dissolved oxygen, 173 mg/l of BOD_5, and a mean fecal coliform bacteria of 9,300,000/100 ml. The other Butler Creek tributary, Phinizy Creek, receives 8,470 pounds per day of BOD_5 from the Augusta sewage treatment plant.
9. Spirit Creek receives daily 7.7 MG of secondary treated unchlorinated effluent from the Fort Gordon sewage treatment plant containing a mean fecal coliform bacteria density of 1,600,000/100 ml and 11,300 pounds of BOD_5 from the Continental Can-Cox Newsprint Paper Mill. Dissolved oxygen downstream of the discharge averages 0.1 mg/l, BOD_5 22 mg/l, and fecal coliform density 1,100/100 ml. The paper mill discharge increased the color in Spirit Creek from 57 to 472 color units.

10. Major waste discharges entering the Savannah River from South Carolina are from the City of North Augusta, Kimberly Clark, the Atomic Energy Commission's Savannah River Plant, and grossly polluted flow from Horse Creek and Lower Three Runs Creek.

11. The City of North Augusta has no waste treatment facilities. Raw wastes discharged directly into the river contained pathogenic *Salmonella* and a mean fecal coliform bacteria density of 24,000,000/100 ml.

12. The daily discharge from Kimberly Clark Paper Company waste lagoons contained 450 pounds of BOD_5, 575 pounds suspended solids, and a mean fecal coliform bacteria density of 170/100 ml.

13. Waste treatment facilities at the AEC Savannah River Plant consist of waste stabilization ponds and septic tanks.

14. The Cities of Aiken and Warrenville and the Gregg Mill, Bath Mill, Seminole Mill, Valchem Chemical Company, and Clearwater Finishing Plant discharge 55,000 pounds of BOD_5 to Horse Creek and its tributaries. Approximately 23,200 pounds of this wasteload reaches the Savannah River.

15. Bottom muds in Horse Creek near the confluence with the Savannah River contained 990 mg/kg of chromium which is toxic to bottom organisms and destroys fish and spawning areas. Approximately 305 pounds per day of chromium flow into the Savannah River from Horse Creek.

16. Sludge deposits in the Savannah River downstream from Horse Creek contained 670 mg/kg of chromium, while immediately upstream chromium concentrations were 32 mg/kg.

17. The J. P. Stevens Mill in Allendale County discharged untreated sanitary and wool scouring wastes into Davis Branch, a tributary to Lower Three Runs Creek. The waste has a population equivalent of 43,000 and severely degraded water quality in Lower Three Runs Creek. The company has submitted waste treatment plans to the South Carolina Pollution Control Authority.

Conclusions

Discharges of untreated and inadequately treated municipal and industrial wastes originating in Georgia and South Carolina cause interstate pollution of the Savannah River (middle reach), endangering the health and welfare of persons in both states. This pollution is subject to abatement under the provision of Section 10 of the Federal Water Pollution Control Act as amended (33 USC 1160).

1. Untreated waste discharges from the sewer system serving downtown Augusta, Georgia, and North Augusta, South Carolina, contribute fecal coliform bacteria contamination to the interstate waters of the Savannah River.
2. None of the wastes discharged to the Savannah River from the Augusta, Georgia, sewerage system are receiving adequate treatment.
3. Chromium deposits causing interstate pollution of the Savannah River result from waste discharges from the Gregg Mill, Valchem Chemical Company, and Clearwater Finishing Plant.
4. Butler Creek, at the confluence with the Savannah River, is grossly polluted by the discharge of 8 MGD of inadequately treated municipal waste from the Augusta sewage treatment plant and from grossly polluted interior drainage from the Augusta, Georgia, area.
5. Oates Creek, Camille Ditch, Rocky Creek, Phinizy Ditch, and Beaverdam Ditch receive untreated and inadequately treated municipal and industrial wastes from the Augusta, Georgia, area and are little more than open sewers.
6. Spirit Creek is polluted by discharges from the Fort Gordon sewage treatment plant and is grossly polluted by the discharge from the Continental Can-Cox Newsprint Paper Mill.

7. Horse Creek and its tributary, Little Horse Creek are grossly polluted from the discharge of more than 11 MGD of untreated textile mill wastes and more than 1.3 MGD of raw and inadequately treated sanitary wastes.
8. Water quality in Horse Creek violated water quality standards adopted by South Carolina.
9. Kimberly Clark Company was providing adequate treatment for its wastes, and the effluent did not have a measurable effect on water quality in the Savannah River.
10. Organic wastes and thermal discharges receiving inadequate treatment from facilities serving the AEC Savannah River Plant cause localized water quality degradation in plant tributaries with no noticeable effect on water quality in the Savannah River.

RECOMMENDATIONS

1. The City of Augusta should upgrade the Butler Creek sewage treatment plant to secondary treatment with a minimum of 85 percent BOD_5 removal by June 1973. All wastes now being discharged without treatment, either directly to the Savannah River or to the existing city system, should be transported to the Butler Creek sewage treatment plant by June 1973. Effective disinfection of plant effluent should be provided at all times.
2. All industrial discharges having adverse effects on the operation of the Butler Creek sewage treatment plant should provide pre-treatment before discharge to the city sewerage system.
3. The City of Augusta should institute a program of separating existing combined storm and sanitary sewers and extending collection and interceptor lines to all sections of the Augusta, Georgia metropolitan area. A report on the feasibility of the sewer separation program should be submitted to the conferees by January 1, 1972.
4. The Columbia Nitrogen Corporation Caprolactam Plant and Nitrogen Plant should either pre-treat their wastes and discharge to the City of Augusta sewerage system or provide the equivalent of secondary treatment to their wastes by December 1972.
5. The Continental Can-Cox Newsprint waste treatment lagoons should be upgraded to provide at least 85 percent reduction of organic wastes by December 1972. These lagoons should discharge directly into the Savannah River through a diffuser to ensure adequate mixing. When applied technology becomes available, the color in the effluent should be reduced to background in the Savannah River at the point of discharge.

6. The Fort Gordon sewage treatment plant should immediately install and operate year-round adequate disinfection facilities.

7. The City of North Augusta, South Carolina, should install and operate satisfactory secondary waste treatment facilities by April 15, 1972, as required by the South Carolina Pollution Control Authority.

7. The City of North Augusta, South Carolina, should install and operate satisfactory secondary waste treatment facilities by April 15, 1972, as required by the South Carolina Pollution Control Authority.

8. The J. P. Stevens Company should install waste treatment facilities to remove at least 85 percent of the organic material by December 31, 1971.

9. The Gregg Mill of the Graniteville Textile Company; the Valchem Chemical Company and the Clearwater Finishing Plant, subsidiaries of United Merchants and Manufacturing Company, should immediately eliminate chromium from their waste discharges.

10. A feasibility study report for a waste collection system and a centralized waste treatment facility for the entire Horse Creek Valley should be submitted to the conferees by December 31, 1971. Discharge from this facility should be directly to the Savannah River.

11. The Atomic Energy Commission Savannah River Plant should provide secondary treatment in accordance with Executive Order 11507. These facilities should be operational by December 1972.

12. The States of Georgia and South Carolina should develop consistent water use classifications and water quality criteria for the Savannah River.

13. The State of South Carolina should establish bacterial criteria for the fish and wildlife water use classification.

14. The State of Georgia should classify all tributary streams to the Savannah River for the same water use classification as the section of the Savannah River to which they discharge. Upon establishment of suitable water quality criteria for these uses, the State of Georgia, in cooperation with EPA, should establish effluent standards for all sources discharging to these streams to ensure that the established uses will be maintained.

15. The State of South Carolina, in cooperation with EPA, should establish effluent standards for all sources of waste on Horse Creek and its tributaries, consistent with water quality criteria set for the classified uses of the stream. These effluent standards should be enforced by not later than May 1, 1973.

DESCRIPTION OF STUDY AND STUDY AREA

Study Area

The study area includes the Augusta Standard Metropolitan Statistical Area (SMSA) (Richmond County, Georgia and Aiken County, South Carolina), the AEC Savannah River Plant and adjacent industries located in Barnwell and Allendale Counties, South Carolina (Figure 1). The Augusta SMSA covers 1,416 square miles and is the terminal point of navigation on the Savannah River. The population of the study area counted by the 1970 census is:

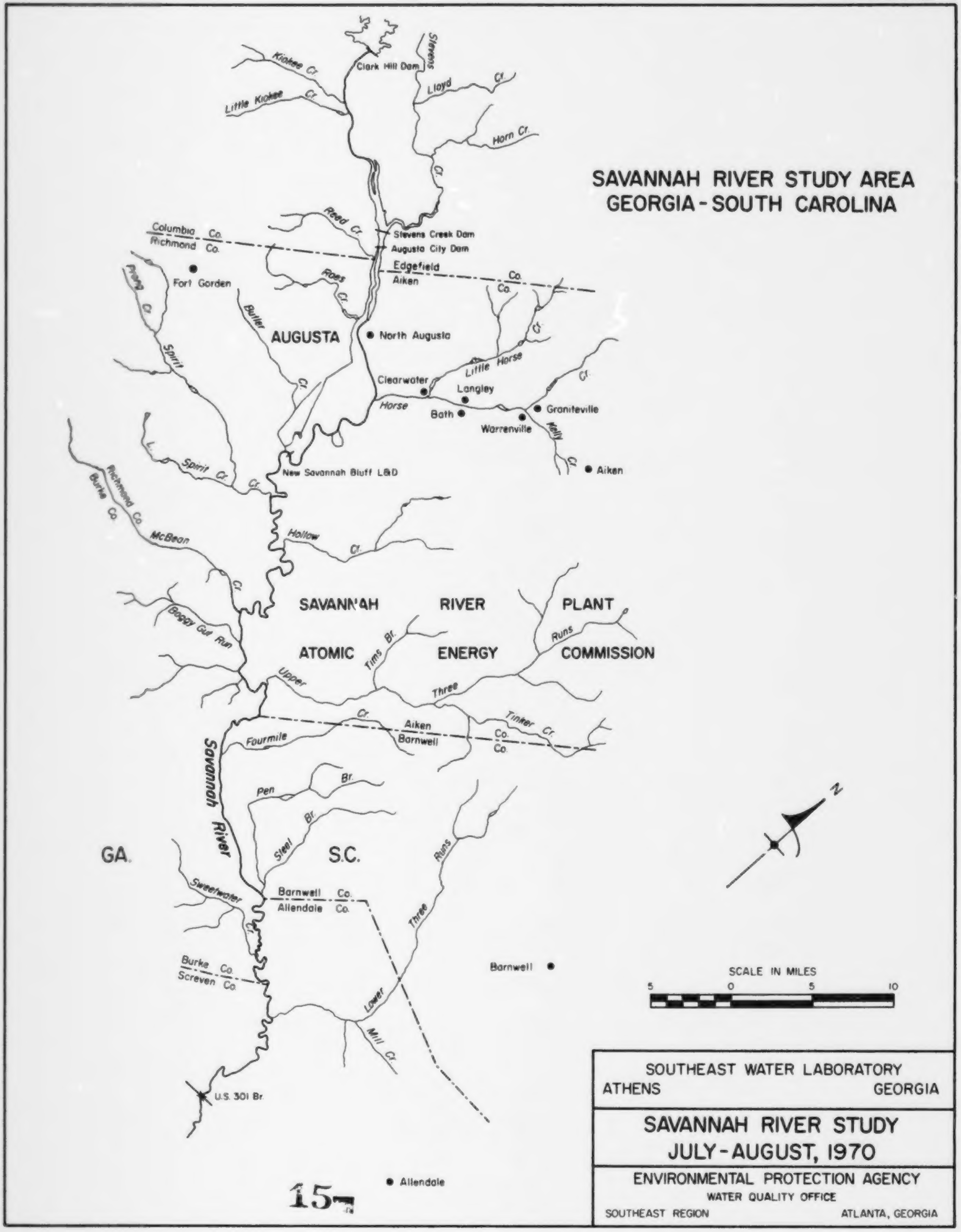
Area Population

	1970
Augusta SMSA	253,460
City of Augusta, Georgia	59,864
Aiken County, South Carolina	91,023
Richmond County, Georgia	162,437
	1985 Projection*
Augusta SMSA	393,000

* Gould Associates, Augusta-Richmond County Planning Commission, "Economic Analysis Augusta-Richmond County," 1969.

The manufacture of textiles, chemicals, pulp and paper along with brick and tile dominate the industrial economy of the area. Richmond and Aiken Counties, as of 1964, employed 8,900 people in the textile industry -- 3,400 employed in Augusta and the remainder in the famed Horse Creek Valley where 14 textile plants represent annually a $15,000,000 payroll and cotton goods valued at $50,000,000.

FIGURE 1


Clark Hill Dam
Kiokee Cr.
Little Kiokee Cr.
Stevens
Lloyd Cr.
Horn Cr.
Cr.
Reed Cr.
Stevens Creek Dam
Augusta City Dam
Columbia Co.
Richmond Co.
Edgefield Co.
Aiken Co.
Fort Gorden
Prong Cr.
Raes Cr.
Butler Cr.
AUGUSTA
North Augusta
Spirit
Little Horse Cr.
Clearwater
Langley
Horse
Bath
Warrenville
Graniteville
Kelly Cr.
Cr.
Aiken
New Savannah Bluff L&D
Spirit Cr.
Cr.
Richmond Co.
Burke Co.
McBean Cr.
Hollow Cr.
SAVANNAH RIVER PLANT
ATOMIC ENERGY COMMISSION
Boggy Gut Run
Tims Br.
Runs
Upper Three
Cr.
Aiken Co.
Barnwell Co.
Tinker Cr.
Fourmile
Savannah River
Pen Br.
Steel Br.
GA.
S.C.
Runs
Sweetwater Cr.
Barnwell Co.
Allendale Co.
Three
Burke Co.
Screven Co.
Barnwell
Lower Mill Cr.
U.S. 301 Br
Allendale
N
SCALE IN MILES
5
0
5
10

SAVANNAH RIVER STUDY AREA
GEORGIA - SOUTH CAROLINA

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY - AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

During the '60's the industrial base of this geographic area began to change. Agriculture products and textiles were being joined by the fast expanding chemical and paper industries. Location of a $45,000,000 paper mill by Continental Can provided the impetus for this industrial development. Industrial parks to accommodate this growth have been established at three sites in Augusta: Miracle Mill, Continental Industrial District, and an industrial district on Gwinnett Street Extension.

Historically the military has played a vital role in the economy of Augusta. The military and civilian complement at the military establishments in this area have tended to fluctuate markedly over the years. Presently, Ft. Gordon (Figure 1) has a military complement of 30,000 plus an estimated 3,000 civilian employees.

Employment projections indicate the heaviest numerical growth in nondurables which includes the big water users -- paper and chemicals. Textiles and the stone, clay, and glass industries will have only a moderate increase. Mining, which is presently very small, will have a 50 percent increase in employment. If technological advancements are made in the extraction and processing of aluminum from kaolin, this could drastically change the mining in this area.

The area is approximately 135 feet above mean sea level and presents a varied topography. The "fall line" (the line along which the rocky terrain of the Piedmont foothills meets the sandy soil of the coastal plain area) passes through Augusta. The surface of the area has been reduced by stream erosion to a series of broad level ridges and valleys with gentle to steep slopes. The terrain slopes gently to the Atlantic seaboard and consists of unconsolidated sand and clay.

The area climate is characterized by hot summers (temperatures exceeding 100°F are common) and mild winters. The lowest rainfall occurs in October and November; the greatest during the summer months.

Climate

Augusta SMSA	Temperature (°F)
Mean Winter	47.3°
Mean Summer	79.2°
Mean Annual	64.0°
Avg. Yrly. Rainfall (in.)	39.18

Flow regimen in the Middle Savannah River (Augusta to Port Wentworth) is regulated directly by Clark Hill Dam, and to a lesser degree by upstream dams at Hartwell, Lake Burton, and Lake Mathis. Clark Hill and Hartwell reservoirs have a combined storage equivalent to one half of the basin's yearly runoff. The average yearly flow of the Savannah River at Augusta is 10,230 cfs.

Completion of Clark Hill in 1954, 22 miles north of Augusta, opened up the river's tremendous power and navigation potential. This multi-purpose dam serves many important functions: guaranteed minimum flows, power generation, recreation, protects fish and wildlife, and prevents flooding.

The Corps of Engineers assures the City of Augusta an average minimum daily flow of 3,000 cfs at the dam. This guarantees the minimum depth of nine feet in the river channel which has developed Augusta into a year-round inland port for barge traffic. However, at the present time river traffic is limited to relatively few products. Less than a dozen barges a week travel between Augusta and Savannah.

The heaviest movements are in the shipment of petroleum products and brick and tile. The development of river transportation is expected to play a major role in Augusta's future economy.

Seven miles above Augusta a low-head dam diverts an average daily weekday flow of 2,800 cfs into Augusta's Industrial Canal. It was built for water supply and power. Presently, King Mills, Sibley, and Enterprise Divisions of Graniteville Mills use the canal's water power. Augusta's water treatment plant withdraws an average of 27 MCD from the canal for potable water supply. Weekend flows in the canal are reduced because the mills shut down.

The Savannah River, an interstate stream, has been classified for water use by Georgia and South Carolina. Tributaries to the Savannah River in Georgia have not been classified but are generally assumed to carry the same classification as the receiving waters. Savannah River classifications are as follows:

Stream Reach	Water Use Classification	Criteria
Clark Hill Dam to Augusta 13th St. Bridge	(Ga. & S.C.) Drinking Water	DO: Ga. & S.C. $\geq$ 4 mg/l pH: Ga. 6.0 - 8.5 S.C. 6.0 - 8.0 Fecal Coliform: Ga.- Not to exceed a mean of 5,000 per 100 ml based on at least 4 samples over 30-day period & not to exceed 20,000/100 ml in more than 5% of samples taken in any 90-day period. S.C.- Not to exceed 2,000/100 ml as a monthly arithmetic average.
Augusta 13th St. Bridge to Upper Three Runs Confluence	(Ga. & S.C.) Fish & Wildlife	DO: Same as above. pH: Same as above. Fecal Coliform: Ga.- Same as above. S.C.- None.

Stream Reach	Water Use Classification	Criteria
Upper Three Runs Confluence to U.S. Hwy 301 Bridge	Ga. - Fish & Wildlife S.C. - Drinking Water	Same as above.

Both states have general criteria which are applicable to all waters. General criteria for both states' discharges requires all to be free from substances in amounts, concentrations, or combinations which are harmful to humans, animals, or aquatic life.

Study Program

Three primary objectives were established for water quality evaluation:

1. To ascertain quantity and quality of municipal and industrial waste discharges in the Augusta-Aiken metropolitan area and their effects on tributary streams and the interstate waters of the Savannah River.
2. To determine whether State-Federal water quality criteria are met in the study area and make recommendations for correction of these problems.
3. To determine the effects of thermal discharges on the quality and uses of the Savannah River.

The first two objectives were pursued during July-August 1970 with chemical, bacteriological, and biological studies being conducted concurrently. Appendices B and C contain results of the bacteriological and biological studies respectively. Objective 3 was evaluated October 1970 and is also referenced in Appendices B and C.

That information pretaining to sampling locations and procedure and analytical methodology is included in Appendix A.

WASTE DISCHARGES AND WATER QUALITY

Major waste discharges to the middle reach of the Savannah River from waste sources in Georgia and South Carolina are in the Augusta area (Figire 2). The major inputs of waste to the Savannah River from Georgia occur through Hawks Gully, Butler Creek, and Spirit Creek. Wastes from the Columbia Nitrogen Caprolactam Plant and Olin Corporation chlorine production plant discharge directly to the Savannah River and were not sampled by EPA. Input from Georgia waste sources account for 61 percent or 44,700 pounds per day of BOD_5 measured in discharges to the Savannah River. This is equivalent to the wastes discharged from a human population of 268,000. Wastes from sources in South Carolina are introduced through Horse Creek and Lower Three Runs Creek, as well as the raw sewage outfall from North Augusta and the secondary treated effluent from Kimberly Clark Paper Company. These sources contribute a total of 28,500 pounds per day of BOD or 39 percent of the total. This is equivalent to the wastes discharged from a human population of 171,000. Total waste loadings to the Savannah River are summarized in Table 1.

Georgia Waste Sources and Tributary Streams

The Savannah River at Augusta receives wastes from untreated domestic and commercial discharges in the downtown Augusta area and from the King, Sibley, and Enterprise Textile Mills. The wastes from the King Mill and Sibley Mill, amounting to slightly more than 1,000 pounds per day of BOD_5, were scheduled to be intercepted and pumped to the Augusta municipal sewage treatment plant at Butler Creek during late summer of 1970. The Entreprise Mill, a subsidiary of the Graniteville Textile Company, discharges wastes to the city sewer system. This section of the system is not presently

Table 1

AVERAGE WASTE LOADINGS (LBS/DAY)
SAVANNAH RIVER

Source or Tributary	R.M.	Discharge (mgd)	BOD_5	TOC	COD	Nitrogenous Compounds (N)			Phosphorus (P)		Solids		Metals	
						TKN	NH_3	NO_2-NO_3	Total	Ortho-P	N-FS	VN-FS	Cr	Hg
Hawks Gully	201.2	503	10,900	22,000	28,100	2,390	1,510	820	189	131	41,950	18,200	-	-
N. Augusta Sewer Outfall	200.7	0.95	842	293	1,420	105	-	1.0	59	57	887	697	-	-
Horse Creek	197.4	83.3	23,200	12,290	40,600	1,210	318	13.5	271	107	50,260	12,300	306	-
Col. Nit. Cap. Plant	194.0	0.40	-	767	2,640	1,210	1,160	190.2	1.7	1.0	-	-	-	-
Kimberly-Clark	192.9	6.89	454	383	862	28.7	6.3	2.9	1.1	0.57	575	402	-	-
Butler Creek	187.0	54.4	21,700	12,250	44,010	4,190	3,800	58	2,640	2,210	19,500	9,530	-	-
Olin Corp.	-	1/	-	-	-	-	-	-	-	-	-	-		0.074 0.506
Spirit Creek	182.8	65.5	12,100	33,000	87,400	1,110	224	8.8	275	197	26,500	16,900	-	-
Lower Three Runs Creek	129.1	27.8	3,990	3,660	10,100	293	138	18	14	12.5	3,250	1.970	-	-

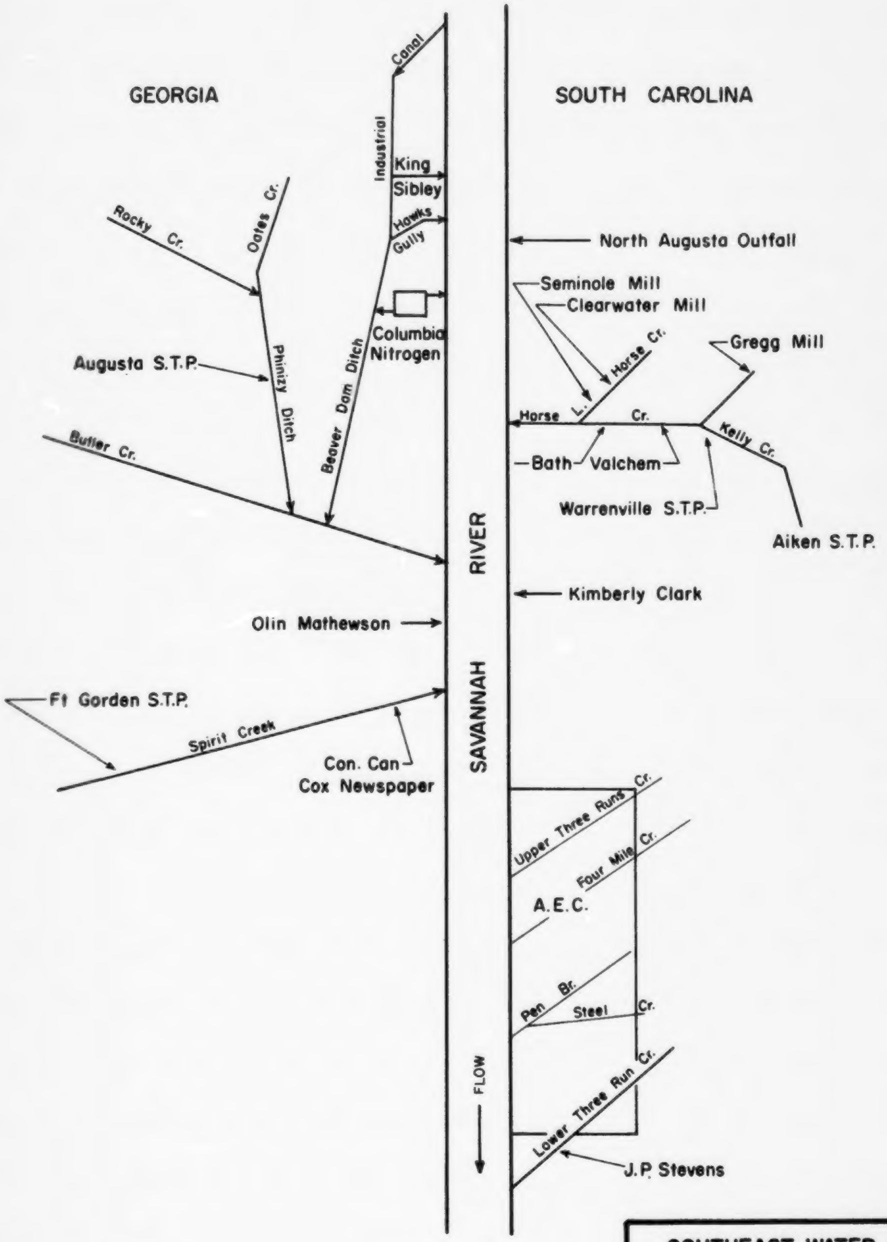
---

1/ Range of daily discharge averaged on weekly basis, October4-December 27, 1970, supplied by Olin Corporation.

- Denotes determination not made.

FIGURE 2

SCHEMATIC OF TRIBUTARIES AND WASTE SOURCES


GEORGIA
SOUTH CAROLINA
Canal
Industrial
King
Sibley
Hawks
Gully
Rocky Cr.
Oates Cr.
Columbia Nitrogen
Augusta S.T.P.
Phinizy Ditch
Beaver Dam Ditch
Butler Cr.
North Augusta Outfall
Seminole Mill
Clearwater Mill
Horse Cr.
Gregg Mill
Horse L. Cr.
Kelly Cr.
Bath
Valchem
Warrenville S.T.P.
Aiken S.T.P.
SAVANNAH RIVER
Kimberly Clark
Olin Mathewson
Ft Gorden S.T.P.
Spirit Creek
Con. Can
Cox Newspaper
Upper Three Runs Cr.
Four Mile Cr.
A.E.C.
Pen Br.
Steel Cr.
Lower Three Run Cr.
FLOW
J.P. Stevens

NOTE: This Drawing Not To Scale

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY-AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

intercepted, and the untreated wastes eventually discharge to the Industrial Canal and to the Savannah River through Hawks Gully (Table 2). Cool water diverted from the Savannah River below Clark Hill Dam and turbulence in the Industrial Canal and Hawks Gully kept dissolved oxygen levels above 6.7 mg/l. However, BOD increased more thanthree-fold, from 0.8 mg/l to 2.6 mg/l, and ammonia nitrogen increased nearly ten times, from .045 mg/l to .40 mg/l. The mean fecal coliform bacteria density increased from 35/100 ml at the intake to the Industrial Canal to 20,000/100 ml in Hawks Gully just upstream from the confluence with the Savannah River. Salmonella, a pathogenic genus of bacteria, were isolated at the Augusta water supply intake, presumably upstream of all sources of waste on the Industrial Canal and at the confluence of Hawks Gully with the Savannah River. However, water samples from North Augusta's potable supply showed no evidence of bacterial contamination. The grossly increased fecal bacterial contamination in the Industrial Canal and Hawks Gully is the result of the discharge of untreated wastes to these receiving waters. Some of the contaminated water from the Industrial Canal escapes to Beaverdam Ditch, a tributary of Butler Creek. Water quality in the Augusta Industrial Canal is summarized in Table 3.

Columbia Nitrogen Corporation discharges contaminated cooling water containing 2,770 pounds per day of ammonia nitrogen and 945 pounds per day of nitrate-nitrite nitrogen. This cooling water flows through a swamp and eventually to Butler Creek. The caprolactam manufacturing process section of Columbia Nitrogen discharges some industrial and domestic wastes with the cooling water to a ditch leading directly to the Savannah River. The 0.4 MGD cooling water discharge contained 1,160 pounds per day of ammonia nitrogen and 190 pounds per day of nitrate nitrogen. The effluent is also extremely high in BOD_5, but toxic components of the waste prevented an

Table 2

AVERAGE WASTE LOADINGS (LBS/DAY)

GEORGIA SOURCES

Source or Tributary	Receiving Stream	Discharge (mgd)	BOD_5	TOC	COD	Nitrogenous Compounds (N)			Phosphorus (P)		Solids		Metal	
						TKN	NH_3	NO_2-NO_3	Total	Ortho-P	N-FS	VN-FS	Cr	Hg
Hawks Gully	Savannah River	503	10,900	22,000	28,100	2,390	1,510	820	189	131	41,950	18,200	-	-
Augusta Wastewater Treat. Fac.	Butler Creek	8.0	8,470	3,340	16,680	1,190	1,150	1.0	1,320	1,270	4,740	3,670	-	-
Columbia Nitrogen	Swamp to Butler Creek	1.1	-	55	165	2,970	2,770	945	4.1	2.57	-	-	-	-
Col.Nit. Cap.Pl.	Savannah River	0.40	-	767	2,640	1,210	1,160	190	1.67	1.03	-	-	-	-
Butler Creek	Savannah River	54.4	21,700	12,250	44,010	4,190	3,800	58	2,640	2,210	19,500	9,530	-	-
Ft.Gordon STP	Spirit Creek	1.74	479	356	972	157	154	64.4	87.1	85.6	377	218	-	-
Con.Can Corp.	Spirit Creek	37.5	11,260	47,700	128,200	1,380	219	9.38	254	172	25,270	25,300	-	-
Spirit Creek	Savannah River	65.5	12,100	33,000	87,400	1,110	224	8.8	275	197	26,500	16,900	-	-
Olin Corp.	Savannah River	-1/	-	-	-	-	-	-	-	-	-	-	-	.074 .056

1/ Range of daily discharge averaged on weekly basis, October 4-December 27, 1970, supplied by Olin Corp.

- Denotes determination not made.

accurate assessment. Samples analyzed by the Georgia Water Quality control Board showed an average BOD_5 concentration of 930 mg/1, or 3,000 pounds per day discharged to the Savannah River.

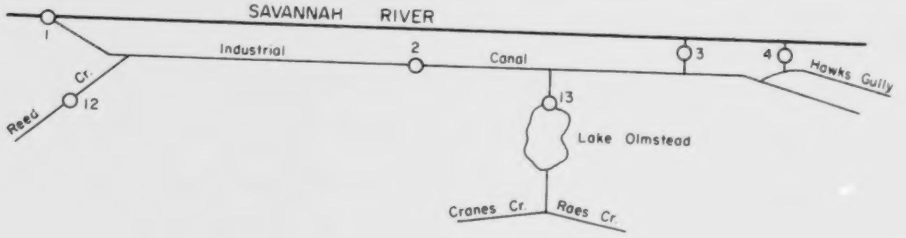
The interior creeks in the Augusta, Georgia, area, such as Oates Creek, Camille Ditch, Rocky Creek, Phinizy Ditch, and Beaverdam Ditch, which eventually flow into Butler Creek, receive untreated and inadequately treated municipal and industrial wastes (Table 3). Water quality at some locations qualified them as open sewers. For example, BOD_5 in Camille Ditch was 215 mg/1, dissolved oxygen zero, and the mean fecal coliform bacteria density 29,000,000/100 ml. The upstream section of Beaverdam Ditch containing wastes draining from the Industrial Canal, has undetectable dissolved oxygen, 173 mg/1 of BOD, and a mean fecal coliform bacteria density greater than 9,300,000/100 ml. Oates Creek and Rocky Creek, while less grossly contaminated, exhibit excessive pollution from untreated waste sources.

Butler Creek, upstream of known waste sources and polluted tributary inflow, has a dissolved oxygen of 8.3 mg/1, BOD of 1.2 mg/1, and a mean fecal coliform density of 600/100 ml. However, pathogenic Salmonella were isolated at the location, indicating an unknown source of waste. Butler Creek also receives, via Phinizy Ditch, the effluent from the City of Augusta's primary sewage treatment plant. During the survey, the plant was treating 8 million gallons per day of wastes. This represents about 30 percent of the total water supply for the Augusta area, indicating that approximately 14 MGD that normally ends up as wastewater either receives no treatment or the status of the treatment is unknown. Since the Augusta plant does not provide adequate treatment, it is reasonable to conclude that none of the wastes discharged to the Augusta, Georgia, sewerage treatment system receives satisfactory treatment.

Table 3
WATER QUALITY SUMMARY
AUGUSTA, GEORGIA INDUSTRIAL CANAL & TRIBUTARIES

Station	IC-1	IC-2	SL-3	RC-12	LO-13	HG-4
DO (mg/l)	6.7	7.0	7.3	6.4	8.4	8.6
Temp (^{o}C)	11.8	11.8	11.9	22.0	21.8	15.1
DO (% Sat)	61	64	67	72	94	85
pH	6.5	6.3	6.5	6.8	6.8	6.7
Alkalinity (mg/l)	14	14	14	24	18	16
BOD_5 (mg/l)	0.8	0.7	0.6	1.8	2.25	2.6
Color (pt-Co U)	27	-	-	-	-	31
Turbidity (JTU)	16	16	18	9.5	14	18.5
TOC (mg/l)	4	5	4	5.5	7	5.25
COD (mg/l)	-	-	6.0	8.0	16	6.7
TKN-N (mg/l)	.40	.11	.40	.30	.31	.57
NH_3-N (mg/l)	.045	.04	.03	.10	.085	.40
NO_3-NO_2-N (mg/l)	.24	.23	.22	.07	< .01	.195
Phosphate-P (mg/l)	.01	.02	.018	.025	.035	.07
Ortho-P (mg/l)	.01	.01	.01	.02	.015	.03
Solids, N-FS (mg/l)	7.5	7.0	12.5	11	20	10
Solids, VN-FS (mg/l)	2.0	-	3	3	10	4.2
Cr. water (mg/l)	0.06	-	-	-	-	.03
Cr. sediment (mg/kg)	-	-	-	-	-	-
Flow (mgd)	-	-	-	0.5	-	503

- Denotes Parameter not determined.


SAVANNAH RIVER
1
Industrial
2
Canal
3
4
Hawks Gully
Reed Cr.
12
13
Lake Olmstead
Cranes Cr.
Raes Cr.

The Augusta sewage treatment plant is designed for a flow of 23 MGD. Both domestic and industrial wastes are received including slaughterhouse, chemical and textile effluents. Pretreatment of industrial waste is not required. An in-plant survey by the Georgia Water Quality Control Board showed BOD_5 and suspended solids removal to be 37 and 38 percent respectively during the EPA study. According to plant records from May through December 1970, the average removal efficiency was 27.9 percent and 45.5 percent respectively for BOD_5 and suspended solids. However, the average removal efficiency during July 1970, the time of the water quality study, was 5.8 percent for BOD_5. Effluent BOD_5 measured during the survey was 8,470 pounds per day, equivalent to a human population of 50,800. The suspended solids effluent was 4,740 pounds per day.

Butler Creek, at the confluence with the Savannah River, was grossly polluted by untreated and inadequately treated municipal and industrial wastes from Augusta, Georgia. The substrate in this reach of the creek was covered with active sludge deposits of decomposing sludge containing 3.9 percent carbon and 81 mg/kg chromium (Appendix C). The average dissolved oxygen was 0.5 mg/1, BOD_5 47.9 mg/1, and average fecal coliform bacteria density 5,900,000/100 ml. Salmonella were recovered at this location. Water quality of Butler Creek and its tributaries is described in Table 4.

Olin Mathieson Corporation discharges approximately 2.5 MGD of waste to the Savannah River and, until May 1970, was the major source of mercury contamination in the Middle Savannah River. At that time, Olin was discharging approximately 12 pounds per day of mercury. Weekly average mercury discharges from October 25 to December 27, 1970 ranged between 0.074 pounds per day and 0.506 pounds per day; on June 15, 1971, EPA results showed a discharge of 0.04 pounds per day.

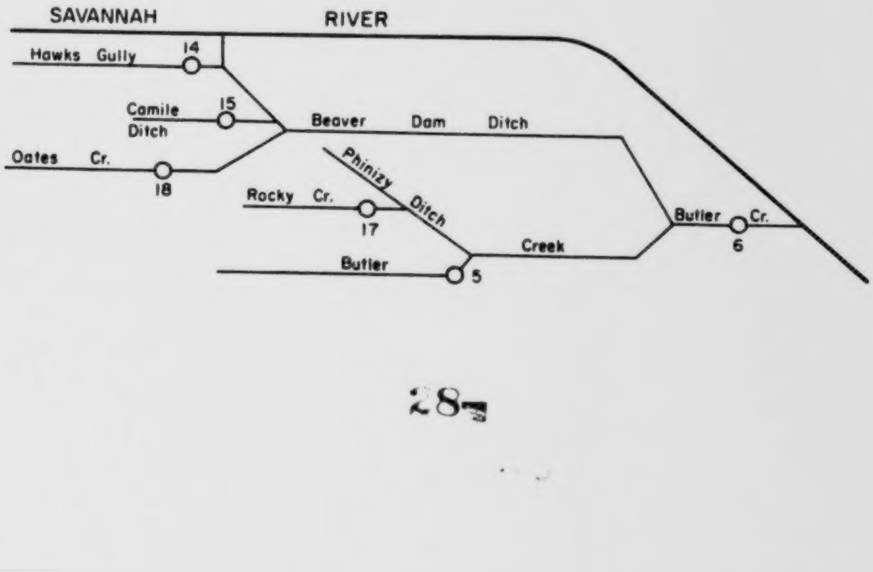
Spirit Creek is polluted by effluents from the Fort Gordon sewage treatment plant and grossly polluted by the discharge from the Continental Can-Cox Newsprint wastewater holding ponds.

Table 4

WATER QUALITY SUMMARY BUTLER CREEK AND TRIBUTARIES

Station	BC-5	BC-6	U-15	OC-16	RC-17	G-14
DO (mg/1)	8.3	.6	0	4.0	1.4	0
Temp (°C)	16.8	21.8	22.5	19.0	20.0	22.3
DO (% Sat)	84	6	0	42.5	15	0
pH	6.8	6.7	6.6	6.8	6.2	6.8
Alkalinity (mg/1)	12	60	101	24	16	99
BOD_5 (mg/1)	1.2	47.9	215	7.2	13.5	173
Color (pt-Co U)	-	-	-	-	-	-
Turbidity (JTU)	17	40	70	19	45	39
TOC (mg/1)	8	27	67	7.5	11.5	40.5
COD (mg/1)	9.4	97	430	16	15	130
TKN-N (mg/1)	.20	9.2	16.4	1.2	1.0	12.0
NH_3-N (mg/1)	.03	8.4	14.5	.7	.28	9.8
NO_3-NO_2-N (mg/1)	.17	.13	.05	.22	.18	.02
Phosphorus-P (mg/L)	.66	5.8	10.7	.87	.12	28
Ortho-P (mg/1)	.59	4.88	9.5	.76	.10	7.2
Solids, N-FS (mg/1)	22	43	196	43	40	60
Solids, Volatile N-FS (mg/1)	7	21	150	23	10	42
Cr. water (mg/1)	-	-	-	-	-	-
Cr. Sediment (mg/kg)	7	81	-	-	-	-
Flow (mgd)	-	54.4	5.55	3.38	3.44	5.1

- Denotes Parameter not determined.


SAVANNAH
RIVER
Hawks Gully
14
Camile Ditch
15
Beaver Dam Ditch
Oates Cr.
18
Phinizy Ditch
Rocky Cr.
17
Butler Cr.
6
Creek
Butler
5

Fort Gordon discharges approximately 1.7 MGD from a secondary plant which had an average removal efficiency during 1970 of 91 percent for BOD_5 and 88 percent for suspended solids. The effluent is not chlorinated, and the average fecal coliform bacteria density is 1,600,000/100 ml. Salmonella were isolated in the effluent.

Water quality in Spirit Creek below the Fort Gordon sewage treatment plant outfall showed an average dissolved oxygen of 3.9 mg/l, BOD_5 of 5.5 mg/l, and elevated nutrient levels (Table 5). Spirit Creek, upstream of the Continental Can-Cox Newsprint waste discharge and approximately 17 miles downstream from the Fort Gordon effluent, exhibited concentrations of fecal coliform bacteria averaging 1,500/100 ml. Salmonella were observed at this location. Dissolved oxygen was 7.2 mg/l, BOD_5 2.8 mg/l, and color 58 units. This reach of the stream supported flora and fauna representative of a healthy environment.

Continental Can-Cox Newsprint discharges approximately 37 MGD to Spirit Creek about one-half mile upstream of the confluence with the Savannah River. The waste receives primary settling and detention in five holding ponds, two of which are aerated. The sludge is pumped to a separate holding pond, and the supernatant from the sludge lagoon is discharged to Spirit Creek. According to Georgia Water Quality Control Board data collected during July 1970, the BOD_5 removal efficiency in the holding ponds was about 73 percent. The discharge to Spirit Creek was 11,260 pounds and 26,270 pounds per day of BOD_5 and suspended solids respectively.

Dissolved oxygen in Spirit Creek downstream of the discharge average 0.1 mg/l, BOD_5 22 mg/l, and 472 color units. The average fecal coliform density was 1,100/100 ml, and Salmonella was recovered. Concentrations of organic carbon, organic nitrogen, and total phosphorus increased ten times in the bottom sediments downstream of the waste discharge. Only very tolerant forms of aquatic life were found in this reach of the creek, and from a biological point of view, the creek is "grossly" polluted. A water quality summary in Spirit Creek is presented in Table 5.

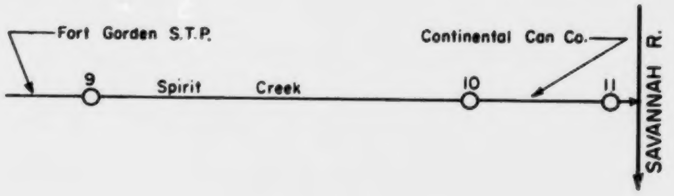
Water quality criteria have not been established for tributary streams in Georgia.

TABLE 5

WATER QUALITY SUMMARY
SPIRIT CREEK

Station	SC-9	SC-10	SC-11
DO (mg/1)	3.9	7. 2	0.09
Temp. (^{o}C)	18.8	19.8	23.4
DO (% Sat)	41	78	1
pH	6.4	6.4	7.1
Alkalinity (mg/1)	12.7	8	100
BOD$_5$ (mg/1)	5.5	2.8	22
Color (pt--Co U)	-	57.5	472
Turbidity (JTU)	12.4	12.4	24.3
TOC (mg/1)	7	6.4	60.3
COD (mg/1)	23	12.5	160
TKN-N (mg/1)	1.51	0.46	2.04
NH$_3$-N (mg/1)	0.98	0.11	0.41
NO$_3$-NO$_2$-N (mg/1)	2.04	0.31	0.016
Phosphorus-P (mg/1)	1.65	0.50	0.51
Ortho-P (mg/1)	1.46	0.43	0.36
Solids, N-FS (mg/1)	12.5	20	48.5
Solids, VN-FS (mg/1)	5.5	4	31
Cr. Water (mg/1)	-	0.16	1.95
Cr. Sediment (mg/kg)	-	0.01	0.09
Flow (mgd)	-	28.0	65.5

- Denotes Parameter not determined.


Fort Gorden S.T.P.
9
Spirit
Creek
Continental Can Co.
10
11
SAVANNAH R.

South Carolina Waste Sources and Tributary Streams

Twelve waste sources discharging either directly or indirectly to the Savannah River were sampled in South Carolina. A summary of waste loadings from these sources is contained in Table 6.

The City of North Augusta, South Carolina, does not have sewage treatment facilities. Approximately 0.95 MGD are discharged raw to the Savannah River just downstream of the 13th Street bridge. The average daily discharge contains 842 pounds of BOD_5, 887 pounds of solids, and a mean fecal coliform bacteria density of 24,000,000/100 ml. Salmonella were isolated in the effluent. The South Carolina Pollution Control Authority is requiring North Augusta to have an acceptable secondary sewage treatment plant in operation by April 15, 1972.

Horse Creek and its tributary, Little Horse Creek, are completely degraded due to the discharge of more than 11 MGD of untreated textile mill wastes and an unquantitied amount of domestic waste which drains directly to Horse Creek due to the lack of an interceptor system. South Carolina has classified these streams for propagation of fish, agricultural, and industrial uses which in area other than swamp areas require a dissolved oxygen greater than 4 mg/l and pH between the range of 6.0 and 8.5. Water quality in Horse Creek is shown in Table 7. Except for two points, one upstream of waste sources and one below a spillway, dissolved oxygen averaged about 1 mg/l and pH ranged between 9.3 and 11.6. The high pH is caused by the alkaline textile waste discharges. Fecal coliform bacteria densities averaged greater than 20,000/100 ml. Color increased from 41 units to 74 units and suspended solids from 6 mg/l to 82 mg/l. Just upstream of the confluence with the Savannah River, chromium concentration in the waters of Horse Creek was 0.44 mg/l; however, bottom sediments contain 990 mg/kg which is toxic to bottom organisms and destroys fish and spawning areas. Approximately 305 pounds per day of chromium flows into the Savannah River from Horse Creek.

The City of Aiken, South Carolina, operates a trickling filter plant discharging 0.95 MGD to Kelly Creek, approximately 2.8 miles upstream from the

TABLE 6

AVERAGE WASTE LOADINGS (LBS/DAY)
SOUTH CAROLINA SOURCES

Source or Tributary	Receiving Stream	Discharge (mgd)	BOD_5	**TOC**	COD	**Nitrogenous Compounds (P)**			**Phosphorus (P)**		Solids		Metals	
						TKN	NH_3	NO_2-NO_3	Total	Ortho-P	**N-FS**	**VN-FS**	Cr	Hg
N.Aug.Sewer Outfall	Savannah R.	0.95	842	293	1,420	105	-	1.03	58.6	57.0	887	697	-	-
Aiken STP	Kelly Cr.	0.93	240	256	931	157	153	7.36	101	96.9	202	140	-	-
Warrenville STP	Kelly Cr.	0.33	105	66	220	50.4	50.4	0.027	30	13.8	110	99.1	0.23	-
Clearwater Fin.Pl.	Little Hrs. Cr.	4.52	24,200	8,710	28,800	459	104	11.3	38.4	32.0	5,840	5,180	7.54	-
Seminole Mill	Little Hrs. Cr.	0.04	26	7	17	0.27	0.06	0.025	0.83	0.76	7.4	4.0	< .01	-
Graniteville Mill	Horse Creek	4.65	30,060	13,650	46,000	244	6.20	20.6	95.80	71.0	6,200	5,350	865	-
Valchem Ch. Co.	Horse Creek	1.61	363	349	1,950	3,810	3650	129	5.9	3.5	362.5	228.3	11.8	-
Bath Mill	Horse Creek	0.303	243	246	354	4.3	0.43	1.5	1.33	0.96	10.1	5.0	0.08	-
Horse Creek	Savannah R.	83.3	23,200	12,290	40,600	1,210	318	13.5	271	107	50,260	12,300	306	-
Kimberly-Clark	Savannah R.	6.89	454	383	862	28.7	6.3	2.9	1.1	0.57	575	402	-	-
J.P.Stevens Company	Lower Three Runs Cr.	0.38	7,240	4,750	23.8	215	93.8	0.3	5.7	4.21	7,920	6,180	0.10	-
Lower Three Runs Cr.	Savannah R.	27.8	3,990	3,660	10,100	293	138	18	14	12.5	3,250	1,970	-	-

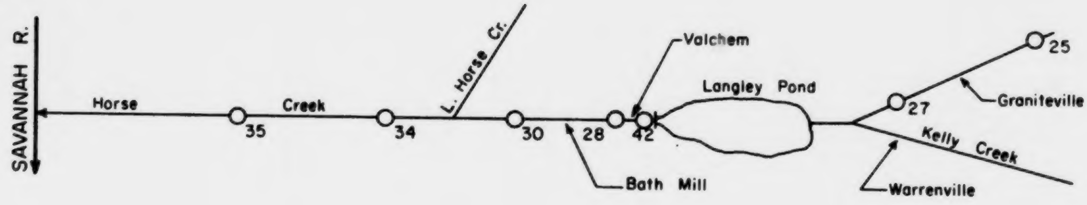
- Denotes determination not made.

TABLE 7

WATER QUALITY SUMMARY
HORSE CREEK

Station	HC-25	HC-27	LP-42	HC-29	HC-30	HC-34	HC-35
DO (mg/l)	7.2	0.8	0.0	5.2	1.3	0.9	1.6
Temp. (°C)	25.5	28.2	28.0	27.8	27.9	28.8	28.0
DO (% Sat)	86	10	-	65	16	11	20
pH	6.1	11.6	9.6	9.8	9.5	9.4	9.3
Alkalinity (mg/l)	4	335	120	153	134	118	94
BOD_5	1.0	122	15	15.5	19	42	28.4
Color (pt-Co U)	41	165	-	-	81	-	74.4
Turbidity (JTU)	7	14	16	17	15.4	26	46.4
TOC (mg/l)	4	75	16	18	22	21	16.9
COD (mg/l)	< 5	200	45	72	43.5	94	62.3
TKN-N (mg/l)	0.15	1.63	0.82	7.9	5.36	5.58	1.50
NH_3-N (mg/l)	0.05	0.04	0.07	6.78	4.07	3.99	0.35
NO_3-NO_2-N (mg/l)	0.05	0.09	< 0.01	0.01	0.03	0.04	0.02
Phosphorus-P (mg/l)	0.01	0.47	0.375	0.49	0.37	0.60	0.37
Ortho-P (mg/l)	0.01	0.29	0.245	0.29	0.24	0.28	0.15
Solids, N-FS (mg/l)	6	27.5	19.5	15.5	17	33	82
Solids, VN-FS (mg/l)	5	20.5	14	9	11.5	17	19.7
Cr. Water	-	-	-	-	-	-	0.44
Cr. Sediment	-	-	-	-	-	-	990
Flow (mgd)	-	41.3	41.3	-	69.8	83.1	83.3

- Denotes Parameter not determined.


SAVANNAH R.
Horse
Creek
L. Horse Cr.
Valchem
Langley Pond
25
Graniteville
27
Kelly Creek
Warrenville
35
34
30
28
42
Bath Mill

confluence with Horse Creek. The plant discharges 240 pounds per day of BOD_5 and 202 pounds per day of suspended solids. Chlorination was not employed during the survey due to equipment failure. Salmonella were isolated from the effluent, and the mean fecal coliform bacteria density in the effluent was 7,500,000/100 ml.

The Warrenville sewage treatment plant, an antiquated facility on Kelly Creek just above the confluence with Horse Creek, is owned by the Graniteville Textile Company and treats 0.33 MGD of wastes from the towns of Warrenville and Graniteville and the Vancluse Mill of Graniteville Textile Company. No chlorination is applied, and the mean fecal coliform bacteria density observed in the effluent was 8,200,000/100 ml. Salmonella were isolated in the effluent which contained 104 pounds per day of BOD_5 and 110 pounds per day of suspended solids. A water quality summary of Kelly Creek is contained in Table 8.

The Graniteville Textile Company's Gregg Mill discharges 4.65 MGD of untreated finishing plant waste into Horse Creek. This waste contains 30,100 pounds per day of BOD_5 equivalent to a population of nearly 181,000, 6,200 pounds per day of suspended solids, and 865 pounds per day of chromium. This waste discharge is the major source of toxic chromium to Horse Creek and the Savannah River. Abatement facilities, consisting of aerated lagoons, were scheduled to be in operation by December 1970, and according to information obtained from the South Carolina Pollution Control Authority these facilities are in operation. The Company estimates a BOD_5 removal of 85 percent in the lagoons.

Bath Mill, a subsidiary of United Merchants and Manufacturing, Inc. discharges 300,000 gallons per day of untreated domestic and industrial waste containing 240 pounds per day of BOD_5 to Horse Creek approximately 4.6 miles upstream from the confluence with the Savannah River.

Valchem Chemical Company, also a subsidiary of United Merchants and Manufacturing, Inc., discharges 1.6 MGD of domestic, industrial wastes and cooling water to Horse Creek about 6.6 miles upstream from the Savannah River.

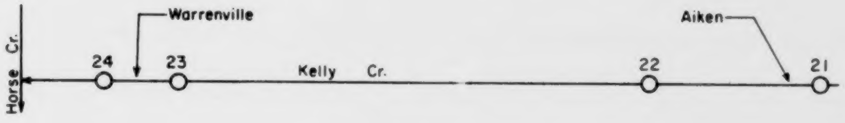
TABLE 8

WATER QUALITY SUMMARY

KELLY CREEK

Station	KC-21	KC-22	KC-23	KC-24
DO (mg/l)	8.5	5.3	5.5	7.8
Temp. (°C)	18.3	18.9	22.1	21.0
DO (% Sat)	89	56	62	86
pH	6.0	6.2	6.2	6.3
Alkalinity (mg/l)	3	7	6	8
BOD$_5$ (mg/l)	0.7	1.9	1.2	1.9
Color (Pt-Co U)	16	-	-	23
Turbidity (JTU)	13	16.4	13.8	12.4
TOC (mg/l	4.7	5.2	6	5.6
COD (mg/l)	<5	7.7	6.0	13.3
TKN-N (mg/l)	0.15	0.41	0.32	0.54
NH$_3$-N (mg/l)	0.05	0.19	0.12	0.37
NO$_3$-NO$_2$-N (mg/l)	0.33	0.94	0.97	0.99
Phosphorus-P (mg/l) 0.0	0.015	0.81	0.74	0.81
Ortho-P (mg/l) 0.01	0.015	0.76	0.74	0.78
Solids, N-FS (mg/l)	10.5	19.5	10	12
Solids, VN-FS (mg/l)	7	7.5	5	7
Flow (mgd)	-	-	-	17.44

- Denotes Parameter not determined.



The Valchem plant waste contained substances which interfered with BOD_5 determinations; however, plant records indicate a daily discharge of 360 pounds of BOD_5. The wastes also contained 3,650 pounds per day of ammonia nitrogen and 12 pounds per day of chromium.

The Clearwater Finishing Plant of United Merchants and Manufacturing, Inc. discharges daily 4.5 MG of untreated domestic and industrial wastes containing 24,200 pounds of BOD_5 which is equivalent to a human population of 145,000. This waste also contains 5,800 pounds per day of suspended solids and 7.5 pounds per day of chromium. The discharge is to Little Horse Creek about 0.3 mile above the confluence with Horse Creek.

Seminole Mill, a subsidiary of United Merchants and Manufacturing, Inc. discharges to Horse Creek downstream from the Clearwater Finishing Plant approximately 0.4 MGD of untreated boiler blowdown water, air conditioning wastewater, and a small amount of domestic wastes.

Based on substrate, chemical and biological changes, discharges from the Clearwater Finishing Plant and Seminole Mill severely degrade water quality in Little Horse Creek (Table 9 and Appendix C). Conditions upstream and downstream of these discharges undergo considerable change -- substrate changes from a cleanly washed sandy, gravel and silt to an active decomposing sludge deposit laden with 163 mg/kg of chromium; background BOD_5 increases from 1.4 mg/l to 173 mg/l, and flora and fauna change from inhabitants indicative of a clean water environment to those representative of a grossly polluted one.

Although more than 55,000 pounds per day of BOD_5 is discharged from waste sources on Horse Creek and its tributaries, only 42 percent or 23,200 pounds per day of this waste was observed at the confluence with the Savannah River.

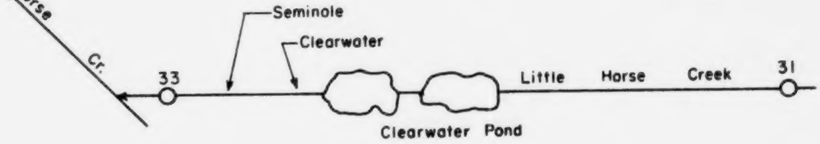
Kimberly Clark Paper Company discharges 6.9 MGD of domestic and industrial waste to a lagoon system with 40 days detention and no disinfection. The daily effluent contained 450 pounds of BOD_5, 575 pounds of suspended solids, and

TABLE 9

WATER QUALITY SUMMARY
LITTLE HORSE CREEK

Station	LHC-31	LHC-33
DO (mg/1	8.1	6.15
Temp (°C)	24.4	29.5
DO (% Sat)	95	79
pH	6.5	10.3
Alkalinity (mg/1)	4	64
BOD$_5$ (mg/1)	1.4	173
Color (Pt-Co U)	66	175
Turbidity (JTU)	18.2	70
TOC (mg/1)	5.4	43.2
COD (mg/1)	8.9	175
TKN-N (mg/1)	0.31	2.98
NH$_3$-N (mg/1)	0.05	0.27
NO$_3$-NO$_2$-N (mg/1)	0.11	0.10
Phosphorus-P (mg/1)	0.05	0.76
Ortho-P (mg/1)	0.04	0.36
Solids, N-FS (mg/1)	17.5	58
Solids, VN-FS (mg/1)	11	57
Cr. Sediment (mg/1)	10	163
Flow (mgd)	-	13.3

NOTE "-" Denotes Parameter Not Determined.


Horse
Cr.
Seminole
Clearwater
33
Little Horse Creek
31
Clearwater Pond

a mean fecal coliform bacteria density of 170/100 ml. The effluent goes directly to the Savannah River through Dead River which consists entirely of waste flow.

The J. P. Stevens Company wool scouring mill in Allendale County, South Carolina, discharges 0.38 MGD of untreated domestic and industrial waste to Davis Branch, a tributary to Lower Three Runs Creek approximately six miles above the creek's confluence with the Savannah River. The daily discharge contains 7,200 pounds of BOD_5 and 7,900 pounds of suspended solids. Although water quality in Davis Branch was not tested, data from three Lower Three Runs Creek sampling stations located above and below the confluence of Davis Branch did show noticeable water quality degradation. The 7.3 mg/l of dissolved oxygen observed at the upstream station was suppressed to 2.2 mg/l by the discharge from Davis Branch. The 1.0 mg/l of BOD_5 observed at the upstream station increased to 17.2 mg/l at the station immediately below the confluence of Davis Branch (Table 10). Biological observations also reflect a similar change (Appendix C). The upstream station supported a diverse community of macroinvertebrates which are indicative of a clean water stream while inhabitants of the reach of the creek downstream of the mill discharge indicate a polluted environment. Although the mean fecal coliform bacteria density was 9,100,000/100 ml, Salmonella were not detected in the waste effluent or in Lower Three Runs Creek.

The Company has submitted plans to the South Carolina Pollution Control Authority for abatement facilities.

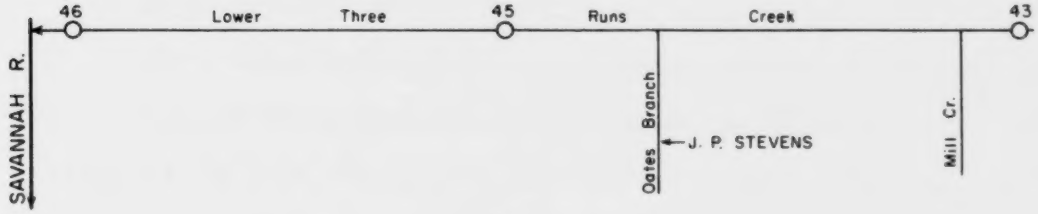
The Savannah River Plant is owned by the Atomic Energy Commission and operated by DuPont. Its primary function is to manufacture materials for national defense; however, other materials are also produced. Waste treatment

TABLE 10

WATER QUALITY SUMMARY
LOWER THREE RUNS CREEK

Station	LTR-43	LTR-45	LTR-46
DO (mg/l)	7.3	3.3	2.5
Temp. (°C)	25.3	25.3	24.2
% Sat.	87	39	29
pH	7.3	7.1	7.0
Alk. (mg/l)	44	50	51
BOD_5 (mg/l)	1.0	17.2	4.28
Color (Pt-Co U)	22	-	-
Turbidity (JTU)	4	16.4	5.8
TOC (mg/l)	3	15.8	7.2
COD (mg/l)	7.45	43.5	15.5
TKN-N (mg/l)	.19	0.83	.54
NH_3-N (mg/l)	.16	.60	.25
NO_2-NO_3-N (mg/l)	.11	.08	.046
Total-P (mg/l)	.03	.06	.05
Ortho-P (mg/l)	.03	.05	.05
Solids, N-FS (mg/l)	4	14	4.5
Solids, VN-FS (mg/l)	-	8.5	2.5
Chromium (mg/l)	0.03	-	0.3
Flow (mgd)	-	27.8	-

NOTE - "-" Denotes Parameter Not Determined.


46
Lower
Three
45
Runs
Creek
43
SAVANNAH R.
Oates Branch
J. P. STEVENS
Mill Cr.

facilities consisting of primary facilities, waste ponds and septic tanks, should be upgraded to secondary facilities consistent with Executive Order No. 11507.

The examination of water quality of streams within the AEC Savannah River Plant during October 1970 indicated no appreciable water quality degradation (Figure 3). Water quality in the tributaries had no noticeable effect on the Savannah River. Steel Creek showed the greatest variation in BOD_5 (0.4 mg/l-7.8 mg/l) with an average BOD_5 of 2.5 mg/l (Table 11). Elevated temperatures were observed at the mouth of Four Mile Creek but did not alter temperatures in the Savannah River. Mean fecal coliform bacteria density in the tributaries did indicate fecal contamination and Salmonella were found at eight stations. Sample results also showed a small increase in the nutrient content of all streams within the plant area with total phosphorus concentrations in Four Mile Creek and Pen Branch approaching levels at which biological nuisances could occur.

Savannah River Water Quality

If all of the waste bearing sources and tributaries flowing into the Savannah River in the Augusta metropolitan area, excluding Hawks Gully, were introduced at one location, the dilution, on a flow basis, would be about 20 to 1 at low weekend flows. With Hawks Gully included, the dilution is still about 6 to 1. When waste sources only are included, the diultion is 60 to 1. Dilution is the primary reason the chemical parameters did not generally indicate appreciable degradation of the Savannah River by waste discharges. The mean dissolved oxygen at all locations in the Savannah River was greater than 6.7 mg/l, and the minimum value observed was 4.4 mg/l (Table 12, Figure 4). However, dissolved oxygen collected from the Savannah

TABLE 11
WATER QUALITY SUMMARY
ATOMIC ENERGY COMMISSION
SAVANNAH RIVER PLANT

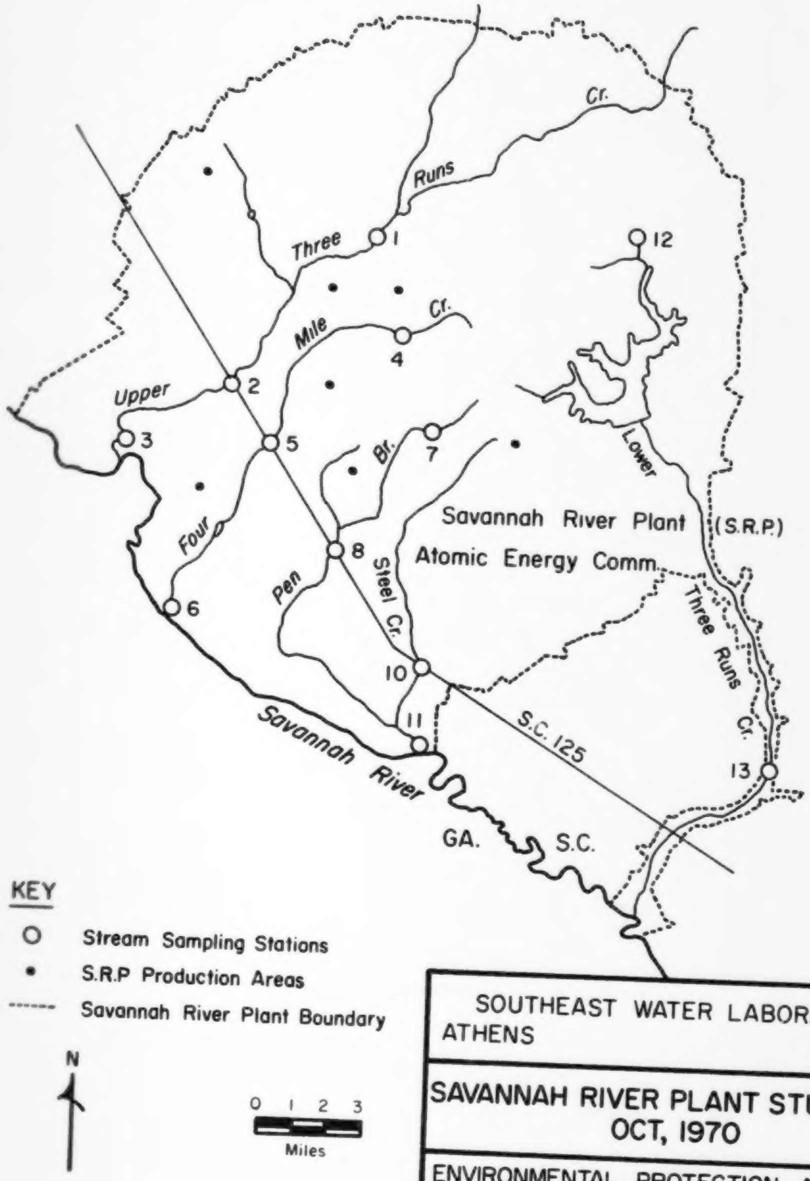
Station	Temp °C	DO mg/1	DO % Sat	BOD_5 mg/1	TOC mg/1	pH	Alk. mg/1	Turb. JTU	TKN-N mg/1	NH_3-N mg/1	NO_2-NO_3-N mg/1	Total-P mg/1	Ortho-P mg/1	Fecal Colif MPN/100 ml	Salmonella Sero-type Detected
UTR-1	16	8.1	81	1.4	6	6.1	4	1	0.27	0.04	0.16	0.04	0.01	410	S. litchfield
UTR-2	16	8.4	85	1.4	7	6.2	5	3	0.24	0.10	0.17	0.04	0.02	270	S. litchfield
UTR-3	15	8.4	82	1.7	8	6.1	5	2	0.52	0.27	0.21	0.03	0.02	550	S. oranienburg
FMC-4	16	7.6	76	1.3	8	6.0	7	2	0.33	0.10	0.30	0.03	0.01	940	S. frankfort
FMC-5	--	6.3	--	1.1	3	6.7	15	3	0.26	0.11	0.38	0.09	0.06	48	None
FMC-6	29	5.9	77	1.5	3	6.5	16	3	0.29	0.10	0.46	0.10	0.08	220	S. litchfield
PB-7	16	8.0	80	1.0	9	6.7	19	2	0.36	0.04	0.06	0.05	0.02	760	S. rubislaw
PB-8	--	7.1	--	1.1	4	6.7	17	3	0.44	0.24	0.38	0.10	0.07	5900	Sample Lost
ST-10	18.5	8.8	93	2.5	5	6.7	22	1	0.20	0.04	0.07	0.02	0.01	430	None
ST-11	18	6.8	72	1.0	4	6.5	18	1	0.27	0.17	0.04	0.04	0.02	85	S. oranienburg
LTR-12	17	7.6	77	1.2	6	6.5	16	2	0.29	0.22	0.18	0.02	0.01	300	S. rubislaw
LTR-13	17	7.9	80	1.1	6	6.6	30	<1	0.22	0.06	0.02	0.05	0.04	96	None

NOTE: Values shown are arithmetic means except for fecal coliform which is geometric

TABLE 12
WATER QUALITY SUMMARY
AVERAGE VALUES FOR THE MIDDLE REACH OF THE SAVANNAH RIVER
JULY-AUGUST 1970

Station No.	River Mile	Temp (°C)	Dissolved Oxygen		pH	Alkalinity (mg/1)	Turbidity (JTU)	Color (Pt-Co U)	BOD (mg/1)	COD (mg/1)	TOC (mg/1)	Nitrogenous Compounds N(mg/1)			Phosphorus-P(mg/1)		Solids(mg/1)	
			(mg/1)	Sat %								TKN	NH3	NO2-NO3	Total	Ortho	N-FS	VN-FS
S50	207.60	21.2	5.9	65	6.7	14	22	47	2.8	9.6	5.0	0.21	0.10	0.17	0.03	0.03	5.0	<1.0
S51-R	200.73	18.8	8.4	89	6.7	15	11	16	1.3	7.7	3.7	0.65	0.14	0.19	0.03	0.03	4.0	1.0
S51-C	200.73	--	--	--	--	--	8	17	--	--	--	--	--	--	--	--	4.5	1.5
S51-L	200.73	19.3	8.8	94	6.7	14	13	13	1.1	<5.0	3.3	0.30	0.12	0.18	0.03	0.03	5.2	2.0
S52-R	199.62	19.0	8.5	90	6.7	14	15	--	0.9	<5.0	3.7	0.11	0.05	0.18	0.03	0.02	2.0	<1.0
S52-C	199.62	--	--	--	--	--	8	15	--	--	--	--	--	--	--	--	3.5	<1.0
S52-L	199.62	19.5	8.5	91	6.7	14	22	--	1.3	7.3	4.0	0.18	0.07	0.18	0.05	0.04	7.0	<1.0
S53-R	197.52	20.0	8.2	89	6.8	14	15	28	1.0	7.6	2.7	0.17	0.06	0.17	0.03	0.04	7.0	<1.0
S53-C	197.52	--	--	--	--	--	8	18	--	--	--	0.11	<0.01	0.14	0.04	<0.01	7.0	6.0
S53-L	197.52	20.0	8.4	91	6.8	15	20	--	1.0	6.1	3.7	0.24	0.08	0.17	0.04	0.04	7.0	1.0
S54-R	195.88	20.5	8.1	89	6.8	17	17	32	1.5	9.6	5.7	0.31	0.06	0.16	0.03	0.03	6.0	<1.0
S54-L	195.88	20.8	9.1	100	6.6	17	17	--	1.1	9.7	4.0	0.22	0.05	0.16	0.03	0.04	6.0	<1.0
S55-R	193.85	21.3	8.2	91	6.9	16	18	--	1.2	17.0	4.3	0.28	0.12	0.16	0.04	0.03	16.0	5.0
S55-L	193.85	21.7	8.0	89	6.8	16	17	--	1.6	9.3	4.3	0.24	0.07	0.15	0.05	0.03	6.0	<1.0
S56-R	192.81	21.5	8.1	90	6.8	16	17	--	1.4	11.0	4.0	0.35	0.23	0.17	0.05	0.03	7.0	<1.0
S56-L	192.81	21.7	8.0	89	6.8	17	21	--	1.4	10.0	4.0	0.38	0.14	0.17	0.06	0.04	6.0	<1.0
S57	188.13	21.2	8.0	88	6.9	17	16	--	1.2	8.2	4.0	0.34	0.22	0.19	0.05	0.03	5.0	<1.0
S58-L	187.05	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11.0	7.5
S58-C	187.05	20.7	9.1	100	6.9	18	10	13	1.3	7.7	3.6	0.53	0.30	0.26	0.04	0.02	13.3	2.7
S59-R	186.56	21.2	8.5	94	6.8	18	14	--	3.2	12.0	4.7	0.77	0.61	0.24	0.37	0.33	8.0	<1.0
S59-L	186.56	21.2	9.6	106	6.8	18	14	--	1.5	8.9	4.0	0.51	0.38	0.23	0.05	0.02	6.0	<1.0
S60	184.80	21.2	8.9	98	6.8	19	15	--	2.2	8.9	3.3	0.69	0.50	0.22	0.23	0.17	8.0	<1.0
S61	182.78	21.5	8.1	9[illegible]	6.8	23	14	27	1.8	9.0	4.0	0.69	0.55	0.20	0.21	0.18	9.0	<1.0
S62-R	181.90	21.8	8.1	9	6.8	23	14	32	2.5	15.0	5.7	0.72	0.51	0.23	0.24	0.20	9.0	<1.0
S62-L	181.90	21.5	8.5	9[illegible]	6.8	20	14	--	1.7	11.0	4.0	0.73	0.50	0.23	0.19	0.18	9.0	<1.0
S63-R	179.60	21.8	7.9	8[illegible]	6.8	21	15	--	2.1	16.0	5.0	0.57	0.39	0.21	0.19	0.17	12.0	1.0
S63-L	179.60	21.8	8.3	93	6.8	21	15	--	1.9	12.0	5.0	0.59	0.37	0.23	0.19	0.17	10.0	<1.0
S64	174.45	22.3	7.8	88	6.8	21	16	--	1.9	14.0	4.0	0.34	0.18	0.22	0.16	0.13	10.0	<1.0
S65	157.20	22.5	7.5	85	6.8	19	17	--	1.7	14.0	4.0	0.28	0.10	0.23	0.10	0.08	14.0	<1.0
S47-A	129.20	24.4	7.0	82	6.8	20	17	30	1.4	11.0	4.0	0.20	0.10	0.36	0.10	0.07	15.0	4.0
S47-C	129.20	26.0	6.6	79	6.7	--	--	19	--	--	--	0.22	0.10	0.38	0.14	0.07	--	--
S47-B	129.20	25.0	7.0	83	6.8	18	16	--	1.3	8.2	3.0	0.29	0.11	0.31	0.08	0.07	9.5	3.0
S48-A	128.08	24.5	6.1	71	6.9	18	17	35	1.1	7.2	3.4	0.29	0.20	0.30	0.07	0.07	16.0	6.0
S48-B	128.08	24.4	7.5	80	6.8	18	19	--	1.1	7.9	3.6	0.34	0.14	0.31	0.10	0.06	6.5	3.0
S49-A	118.80	25.5	7.6	90	6.8	18	14	--	1.1	9.2	3.8	0.22	0.08	0.35	0.06	0.06	9.0	5.0
S49-B	118.80	25.5	7.4	88	6.9	18	14	--	1.2	9.6	3.8	0.22	0.06	0.35	0.08	0.06	9.5	4.5

FIGURE 3

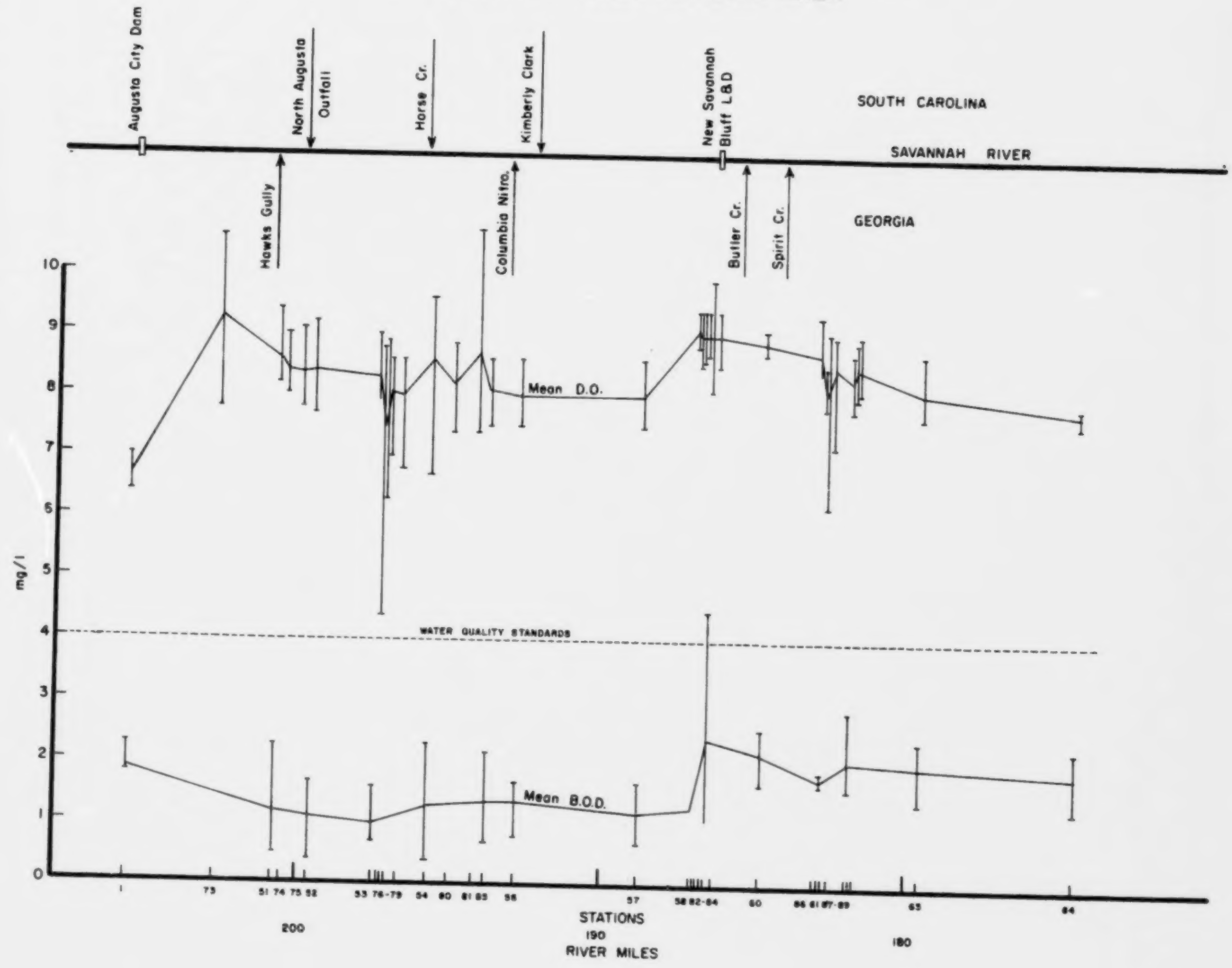

Three Runs Cr.
Upper Three Mile Cr.
Four Mile Cr.
Pen Br.
Steel Cr.
Lower Three Runs Cr.
Savannah River Plant (S.R.P.)
Atomic Energy Comm.
Savannah River
S.C. 125
GA.
S.C.
1
2
3
4
5
6
7
8
10
11
12
13
KEY
Stream Sampling Stations
S.R.P Production Areas
Savannah River Plant Boundary
N
0 1 2 3
Miles

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER PLANT STUDY AREA
OCT, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

FIGURE 4
DISSOLVED OXYGEN & BIOCHEMICAL OXYGEN DEMAND
SAVANNAH RIVER - AUGUSTA AREA



River over a 24 hour period showed that: (1) The oxygen demanding waste load imposed on this section of the Savannah River was not constant, and (2) the waste load imposed was of sufficient magnitude to obscure the effects of the photosynthetic and respiratory activity of the dense growths of vascular aquatic plants which were present (Appendix C). Total Kjeldahl nitrogen in the Savannah River is noticeably increased from 0.12 mg/l to 0.48 mg/l by discharges from Hawks Gully. Butler Creek and Spirit Creek discharges increased Kjeldahl nitrogen in the Savannah River from 0.4 mg/l to 0.63 mg/l and from 0.54 mg/l to 0.69 mg/l respectively (Figure 5).

Waste from the North Augusta raw sewage outfall, Hawks Gully, and Horse Creek increase the percentage of organic carbon deposits in bottom sediments on the Georgia side of the Savannah River from 0.3 to 3.9 (Table 13). Carbonaceous material in sludge deposits on the South Carolina side of the river increased from 1.66 percent upstream of the North Augusta outfall to 3.02 percent downstream of the outfall. Organic carbon greater than 3.0 percent in sediment indicates artificial deposition by waste sources.[2] Organic carbon content increased from 2.82 percent upstream of Horse Creek to 5.83 percent downstream, indicating substantial waste input to the interstate waters of the Savannah River from Horse Creek.

Bacteriological contamination, however, increased markedly due to untreated and inadequately treated waste discharges introduced to the Savannah River from Georgia and South Carolina sources (Appendix B). A mean fecal coliform bacteria density of 35/100 ml was observed upstream of all sources of wastes. Discharges from Hawks Gully and from the North Augusta sewage outfall increased fecal coliform bacteria densities to 29,000/100 ml and 12,000/100 ml respectively on the Georgia and South

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[2] Organic Carbon - Organic Nitrogen Ratios in a Polluted Estuary, Finger, J. H. and Wastler, T. A. - Journal of the Water Pollution Control Federation, Research Supplement, February 1969.

TABLE 13

SAVANNAH RIVER

SEDIMENT COD

Station	Date 1970	COD (mg/kg)	Organic Carbon (%)
	August		
S-73A (L)	4	44,400	1.66
S-73 (R)	4	7,900	0.30
S-75 (L)	4	80,600	3.02
S-75 (R)	4	17,700	0.66
S-53 (L)	4	6,160	0.23
S-53 (R)	4	75,400	2.82
S-76 (L)	4	155,600	5.83
S-76 (R)	4	104,100	3.90
S-78 (L)	4	69,100	2.59
S-78 (R)	4	65,200	2.44

% = COD divided by 2.67 divided by 10,000.

L and R = left or right side of river looking downstream.

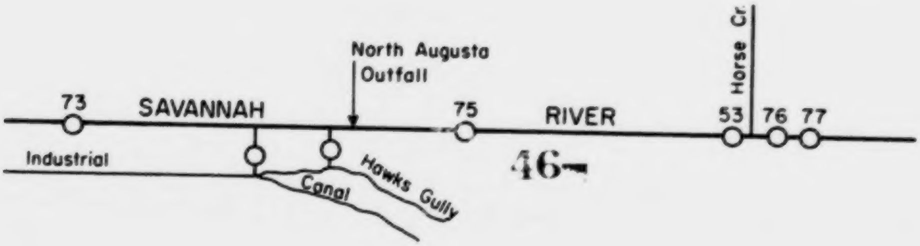
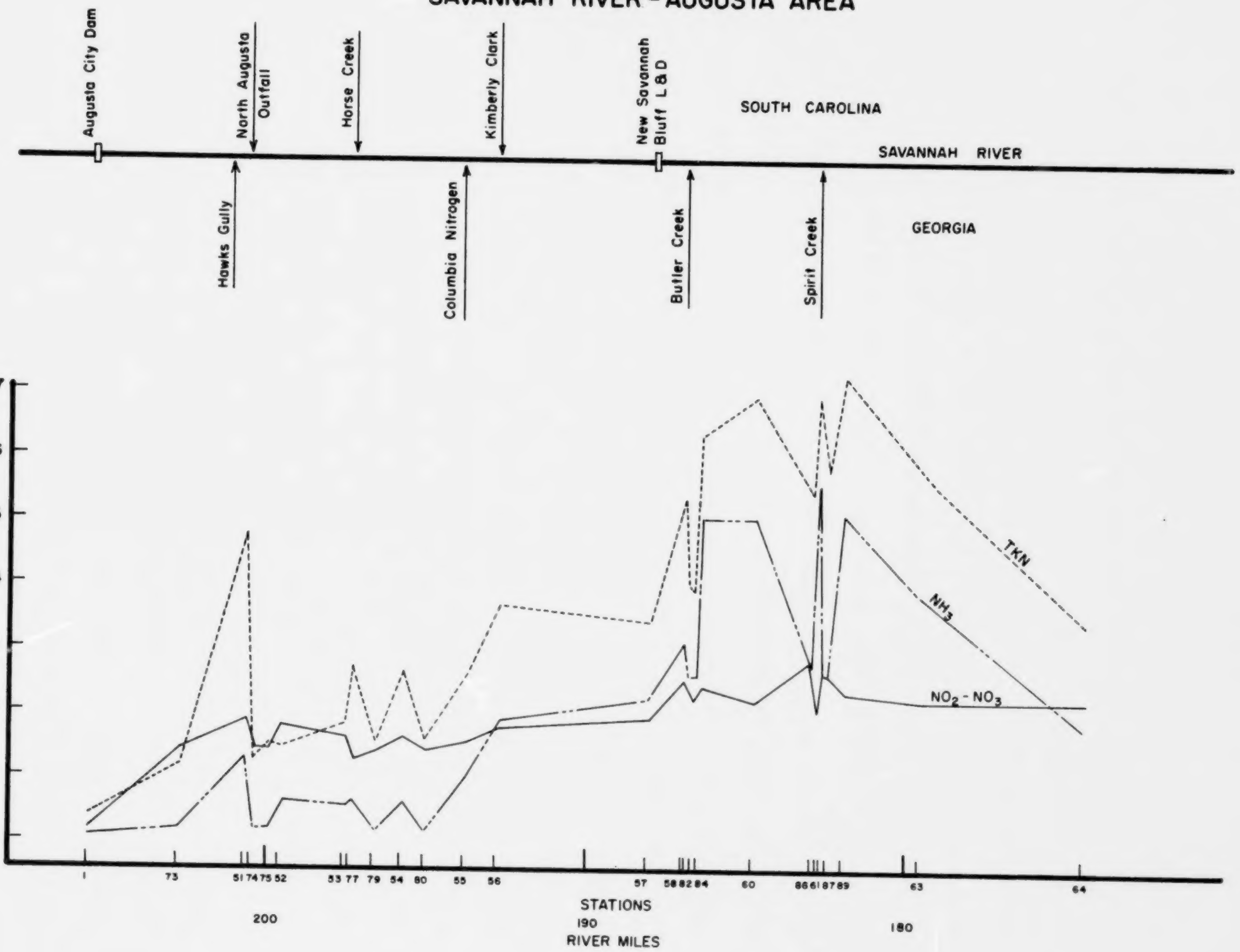

North Augusta
Outfall
Horse Cr.
73
SAVANNAH
75
RIVER
53
76
77
Industrial
Canal
Hawks Gully

FIGURE 5
NITROGEN COMPOUNDS
SAVANNAH RIVER - AUGUSTA AREA



Carolina sides. The Georgia bacterial criterion for fishing and fish propogation (5,000 fecal coliform bacteria per 100 ml) was exceeded from the North Augusta Sewage outfall for the next 18 miles to below the confluence of Spirit Creek. The effect of Horse Creek discharges was not apparent in the Savannah River. However, Butler Creek waste discharges increased fecal coliform bacteria densities on the Georgia side of the river to 160,000/100 ml. Below Spirit Creek, the fecal coliform bacteria density on the Georgia side increased from 44,000/100 ml to 89,000/100 ml. Lower Three Runs Creek discharge did not adversely affect the bacterial quality of the Savannah River. With the exception of the control station, pathogenic Salmonella were isolated at all Savannah River stations in the 74 mile reach sampled. Of the tributaries entering the Savannah River in the study area, discharges from Butler Creek had the greatest detrimental effect on the bacterial quality of the river.

A slimy fibrous sludge deposit covers the bottom of the Savannah River for a distance of 1,000 yards below the confluence of Horse Creek (Appendix C). These sludge deposits, containing 51 to 670 mg/kg of chromium and 3.9 to 5.8 percent organic carbon, are having adverse effects on the biological species in the deposits. Concentrations of chromium in the Savannah River upstream from the Horse Creek confluence are 32 mg/kg. These chromium deposits result from waste discharges from the Gregg Mill of Graniteville Textile Company, Valchem Chemical Company, and the Clearwater Finishing Plant of United Merchants and Manufacturing, Inc.

APPENDIX A

SAMPLING LOCATIONS, PROCEDURE AND ANALYTICAL METHODOLOGY

AUGUSTA AREA - GEORGIA SIDE

Daily Sample Stations

IC-1 Industrial Canal at drawoff point from Savannah River north of Interstate 20. Collected at base of stone divider extending downstream into the canal from the intake gates.

IC-2 Industrial Canal at Augusta water treatment plant, off of catwalk running along side of 12 inch water main six miles below IC-1.

SL-3 Water supply intake from Industrial Canal for Sibley textile mill downstream side of mill control gate off of gravel road bridge.

HG-4 Hawks Gully outlet from the Industrial Canal at the downstream side of the 15th Street bridge in downtown Augusta.

BC-5 Butler Creek at downstream side of New Savannah Road bridge Ga. Hwy 56 about 2.4 miles above Savannah River confluence.

BC-6 Butler Creek on the downstream side of old truss bridge inside Corps of Engineers New Savannah Bluff Lock and Dam Park and 0.1 mile above the Savannah River confluence. Below confluences of Phinizy Ditch and Cason Dead River.

SC-9 Spirit Creek downstream side of U.S. 1 bridge 16.5 miles above Savannah confluence.

SC-10 Spirit Creek from downstream side of Old Savannah Road bridge Ga. Hwy 56 approximately 3.0 miles above Savannah confluence.

SC-11 Spirit Creek one hundred yards above the Savannah River confluence and above the river's backwaters.

Intermittent Sample Stations

FG-7 Fort Gordon sewage treatment plant influent; located behind comminutor.

FG-8 Fort Gordon sewage treatment plant effluent; at overflow weir of secondary clarifier.

RC-12 Reed Creek from Stevens Creek Road culvert.

LO-13 Lake Olmstead drainage to Industrial Canal at downstream side Lake Shore Loop Extension road bridge 0.5 mile from Industrial Canal.

G-14 Gwinnett Street drainage at culvert 1/2 block east of U.S. Hwy 78 on Gwinnett Street.

U-15	Camille Street ditch downstream side of culvert near Shapiro Packing Company.
OC-16	Oates Creek at downstream side of culvert 1/4 mile south from Shapiro Packing Company.
RC-17	Rocky Creek at downstream side of culvert on New Savannah Road (Loop 56) two miles from U.S. hwy 78 junction.
CN-18	Columbia Nitrogen Caprolactam plant effluent.
CN-18'	Columbia Nitrogen Plant effluent.
BC-19	Butler Creek sewage treatment plant at New Savannah Road (Loop 56).
CC-20	Continental Can paper mill effluent taken from their Pond 5 discharge.
CC-21	Continental Can sludge pond effluent.

Daily sample collection was performed July 6-10, 1970 and intermittent collection July 7, 8, and 9, 1970. All samples were collected once per day except: FG-7, FG-8, CN-18, CN-18', BC-19, CC-20 and CC-21; FG-7, 8, was a special study conducted at Fort Gordon July 6-9. Automatic samplers for set-up for 72 hours of continuous collection with determinations performed every 24 hours; station samples CCN-18, 18', BC-19 were each composites obtained July 8 and 9 by the Georgia Water Control Board; CC-20, 21 were also identified by the Georgia Water Quality Control Board. August 15 and 16, 1970, CC20 was 2-24 hour composites, CC21 was two grabs.

All samples were routinely analyzed for BOD_5, DO, fecal coliform bacteria, nitrogen and phosphorus series, TOC, pH, temperature and turbidity. BOD_2 alkalinity, COD, and total volatile and suspended solids were only determined July 6 and 7. Color was always analyzed at IC-1, HG-4, CC-20, SC-10 and SC-11. Sulfides and chromium always determined at IC-1 and HG-4. Salmonella detection using the swab technique was performed at IC-2, HG-4, BC-6, FG-8, SC-10 and SC-11.

SPECIAL STUDIES

HORSE CREEK VALLEY - SOUTH CAROLINA SIDE

Procedure

Sampling stations were discriminately positioned on Horse Creek and tributaries in Horse Creek Valley (i.e. Kelly Creek, Little Horse Creek and Horse Creek). Control stations above all waste sources were used to define the relative change in water quality. Significant industrial and municipal waste source inputs were sampled concurrently with the tributary stations. All waste source samples were collected as the treated or untreated effluent discharged to the environment. Tributary samples were obtained from the midpoint in steam flow below the surface from bridges or culverts.

Sampling was conducted July 13-17, 1970. Field operations were separated into three coordinated efforts:

1. Daily collection of tributary and waste source points.
2. Intermittent collection of tributary and waste source points.
3. Special studies - composite sampling of three municipal waste sources

Daily Collection

The following sample stations were collected as grab samples, once per day, July 13-17:

Horse Creek - 25 -- South Carolina highway 33 bridge upstream from Graniteville Company effluent discharge and 10.5 miles above the Savannah River confluence.

Graniteville Mill - 26 -- Waste source to Horse Creek from Gregg Mill operations. Located at wastewater pumphouse prior to discharge and 10.0 miles above Savannah River confluence.

Horse Creek - 27 -- 0.5 mile downstream of Graniteville Company complex at South Carolina Hwy bridge 104.

Kelly Creek - 21 -- Located just above the Aiken City sewage treatment plant discharge on Dibble Road bridge 3.0 miles upstream from the Horse Creek confluence.

Kelly Creek - 22 -- Below the Aitken STP discharge at South Carolina Hwy 421 culvert 1.6 miles above the Horse Creek confluence.

Kelly Creek - 23 -- One hundred yards upstream from the Warrenville sewage treatment plant discharge. A bridge station with sample collection from a small man-made pond just before overflow passes over the weir

Kelly Creek - 24 -- Approximately 0.1 mile below the Warrenville STP discharge to Kelly Creek. The downstream side of South Carolina Hwy bridge 81.

Valchem - 28 -- Chemical division of United Merchants and Manufacturers, Inc. South Carolina Hwy 421, Langley, South Carolina. Waste source discharging from two outfalls 40 yards apart into Horse Creek.

Horse Creek - 29 -- 0.2 mile below Valchem's discharge at South Carolina Hwy 254 bridge. About 6.4 miles above the Savannah River confluence.

Horse Creek - 30 -- 0.8 mile below Bath's waste discharge at 421 bridge.

Little Horse Creek - 31 -- Located 1.4 miles above the Clearwater Finishing Plant wastewater discharge at South Carolina Hwy 67 bridge.

Clearwater Finishing Plant - 32 -- Industrial waste source discharging into Little Horse Creek 0.3 mile upstream of the Horse Creek confluence. All samples were obtained on plant as wastewater flume releases to Little Horse Creek.

Little Horse Creek - 33 -- Below all waste sources discharging into Little Horse Creek at South Carolina Hwy 421 bridge, 0.2 mile upstream from the Horse Creek confluence.

Horse Creek - 34 -- At South Carolina Hwy 145 one mile below the confluence of Little Horse Creek and Horse Creek but above any inputs from an existing Kaolin mine operation.

Horse Creek - 35 -- Below all waste sources into Horse Creek Valley. Located at South Carolina Hwy 125, U.S. Hwy 78 bridge 2.4 miles upstream from the Savannah River.

All tributary and waste source collection points were routinely analyzed for BOD_5, dissolved oxygen, fecal coliform bacteria, nitrogen and phosphorus series, TOC, pH, temperature, turbidity, and color. Horse Creek sampling station 35 and the industrial waste source samples (i.e. Graniteville Mill, Clearwater Finishing Plant, Valchem) were also routinely analyzed for Linear Alkayl Sulfonate (biodegradable detergents), pesticides, sulfide and color. Salmonella detection was for 5 days at selected tributary stations (i.e. HC-25, HC-27, HC-30, LHC-31, LHC-33 and HC-35). Total and volatile suspended solids, BOD_2, alkalinity and COD were collected only twice during the five day schedule.

Temperature, dissolved oxygen, pH, BOD, fecal coliform bacteria, and turbidity were determined in the field, whereas, the remaining parameters were preserved, if necessary, and transported back to the Southeast Water Laboratory, Athens, Georgia.

Intermittent

Scheduling required collection only three times July 13-17, except for

Langley Pond, which was sampled twice. The included stations were:

Bath Mill - 38 -- A Horse Creek waste source located at Bath, South Carolina. Only one effluent line discharges to Horse Creek 4.6 miles above the Savannah River confluence.

Seminole Mill - 39 -- Division of United Merchants and Manufacturers, Inc., industrial waste source discharging to Little Horse Creek located adjacent to Clearwater Finishing Plant, Clearwater, South Carolina. One collection point, on plant, as the wastewater is released from their 6-inch outfall line to Little Horse Creek approximately 0.3 mile above the Horse Creek confluence.

Kimberly Clark - 40 -- Beech Island, South Carolina, was sampled below their lagoon discharge at the U.S.G.S. gaging station on the Dead River.

Langley Pond - 42 -- A man-made impoundment of Horse Creek. Collection was approximately 100 yards above the Valchem discharges to Horse Creek just before the impounded water passed through the flood control gates.

All waste sources were routinely analyzed for 5-day BOD, dissolved oxygen, fecal coliform, nitrogen and phosphorus series, TOC, pH, temperature, and turbidity. Pesticides, LAS, 2-day BOD, sulfides, chromium, alkalinity, and COD were intermittently determined once. Langley Pond[illegible]42 followed the same schedule except pesticides, sulfides, LAS, and chromium were ommitted from intermittent determinations.

Special Studies

Composite sampling was performed at Warrenville Sewage Treatment Plant (STP), Aiken STP, and North Augusta outfall (W-36, A-37 and NA-41). Serco automatic samplers were used every hour. Bacteriological analyses were obtained by grab sampling. *Salmonella* detection continued for five days by hanging a cloth swab in the wastewater at the collection point. Determinations made in the field were: pH, BOD_5, BOD_2, turbidity and fecal coliform bacteria. The remainder (sulfides, chromium, TOC, COD, alkalinity, total volatile suspended solids, total suspended solids, phosphorus and nitrogen series, and LAS) were preserved, if necessary, and transported back to the Southeast Water Laboratory, Athens, Georgia.

LOWER THREE RUNS

Procedure

Samples were obtained by car and boat on July 20-22, 1970. All stations were sampled twice per day, time permitting. Samples were shuttled back to the mobile lab in Augusta for analysis and/or preparation for shipment to the Southeast Water Laboratory, Athens. The tributary station samples were collected one foot below the surface using a Kemmerer sampler. Savannah River stations were collected two feet from the bottom on the first run and one foot from the surface on the last. J. P. Stevens was the only waste source sampled.

All samples were routinely analyzed for BOD_5, DO, nitrogen and phosphorus series, TOC, pH, temperature and turbidity. Intermittent determinations on samples collected the first run July 20 and 21 were: BOD_2, alkalinity, COD, and total and volatile solids. Bacteriological analyses were fecal coliform bacteria and *Salmonella* detection. Fecal coliform bacteria samples were obtained on the first run each day at stations LTR-43, JPS-44, LTR-45, and LTR-46. Cloth swabs for *Salmonella* detection were fixed for five days at stations LTR-43, JPS-44, LTR-46, S-47-A and S-47-B. These same stations were intermittently (first run, July 20 and 21) analyzed for color, pesticides, sulfides, and Linear Alkyl Sulfonate (biodegradable detergents).

Vehicle Stations

Lower Three Runs - 43 -- South Carolina Hwy 66 bridge upstream of Stevens Mill effluent and 6.7 miles above the Savannah River confluence.

J. P. Stevens - 44 -- Waste source 0.5 mile north of South Carolina Hwy 125 on Hwy 3, Allendale County. Sampled at concrete collection box behind plant.

Lower Three Runs - 45 -- Hwy 125 bridge below Stevens effluent and 4.0 miles above Savannah River confluence.

Boat Stations

Lower Three Runs - 46 -- Approximately 50 yards upstream from Savannah River confluence.

Savannah River - 47A & B-- Approximately 0.1 mile upstream of Lower Three Runs confluence (R.M. 129.2). "A" is the left third point looking downstream, "B" is the right third point.

Savannah River - 48A & B -- One mile below Lower Three Runs confluence at Little Randall Point (R.M. 128.2) - "A" and "B" as above.

Savannah River - 49A & B -- North bound U.S. 301 bridge (R. M. 118.8) - "A" and "B" as above.

The following is a complete listing of all the stations used in the chemical, biological and bacteriological phases of the study.

STATION DESCRIPTIONS (River mile in parenthesis)

S72 - 100 yards above the South Carolina Utilities Dam (207.62)

S50 - At the Augusta City Dam (207.60)

S73 - At North Augusta water intake (202.72)

S51 - 100 yards north of 13th Street Bridge (200.73)

S74 - 200 yards south of 13th Street Bridge (200.52)

S75 - Opposite 8th Street (200.00)

S52 - At 5th Street boat ramp (199.62)

S53 - 200 yards above the mouth of Horse Creek (197.52)

S76 - 100 yards below the mouth of Horse Creek (197.34)

S77 - 300 yards below the mouth of Horse Creek (197.26)

S78 - 500 yards below the mouth of Horse Creek (197.14)

S79 - 1,000 yards below the mouth of Horse Creek (196.70)

S54 - 200 yards upstream of highway 28 bridge (195.88)

S80 - Slightly downstream of channel marker #96 (195.10)

S81 - 300 yards below the Columbia Nitrogen outfall ditch adjacent to the Columbia Nitrogen water intake (194.22)

S55 - 850 yards below the Columbia Nitrogen waste ditch (193.85)

S56 - 200 yards downstream of the Kimberley Clark-Dead River waste discharge (192.81)

S57 - 100 yards upstream of the New Savannah Bluff Lock and Dam (188.13)

S58 - 100 yards upstream of the mouth of Butler Creek, but below the New Savannah Bluff Lock and Dam (187.05)

S82 - 100 yards below the mouth of Butler Creek (186.88)

S83 - Adjacent to boat ramp 300 yards below the mouth of Butler Creek (186.80)

S84 - 500 yards below the mouth of Butler Creek (186.70)

S59 - At new Savannah Bluff Landing offshore of farthest downstream boat ramp (186.56)

S85 - 1,200 yards below the mouth of Butler Creek at channel marker #95 (186.30)

S60 - Upstream of Twiggs Lower Bar and Continental Can water intake channel (184.80)

S86 - 300 yards above the mouth of Spirit Creek, slightly below channel marker #87 (183.00)

S61 - 100 yards above the mouth of Spirit Creek (182.78)

S87 - 100 yards below mouth of Spirit Creek (182.72)

S88 - 300 yards below the mouth of Spirit Creek (182.62)

S89 - 500 yards below the mouth of Spirit Creek (182.52)

S62 - Slightly above Bailey's Cut but below the mouth of Spirit Creek (181.90)

S90 - Adjacent to channel marker #86 at the mouth of Bailey's Cut (181.82)

S91 - 100 yards below the mouth of Bailey's Cut (181.70)

S63 - At Hill's Landing by channel marker #84 (179.60)

S64 - At the Silver Bluff Landing opposite the ramp (174.45)

S65 - At the Savannah River Plant automatic monitor intake (157.20)

S47 - 150 yards above the mouth of Lower Three Runs Creek (129.20)

S66 - 100 yards below the mouth of Lower Three Runs Creek (129.00)

S67 - 300 yards below the mouth of Lower Three Runs Creek (128.82)

S68 - 500 yards below the mouth of Lower Three Runs Creek (128.64)

S69 - 700 yards below the mouth of Lower Three Runs Creek (128.52)

S70 - 1,000 yards below the mouth of Lower Three Runs Creek (128.36)

S71 - 1,500 yards below the mouth of Lower Three Runs Creek (128.14)

S48 - One mile below the mouth of Lower Three Runs Creek (128.08)

S49 - At U.S. 301 bridge (118.80)

ANALYTICAL METHODOLOGY

The following methods were used by Environmental Protection Agency personnel:

Analyses	Method	Reference
pH	Laboratory Instrument Meter	FWPCA Methods Manual Nov. 1969
Temperature	Fischer Scientific Dail Thermometer	
DO	Modified Winkler with Full-Bottle Technique	
BOD	As prescribe (Dilutian water a 50-50 solution of distilled and Savannah River water obtained at New Savannah Bluff Lock and Dam)	FWPCA Methods Manual Nov. 1969
Kjeldahl Nitrogen	Technicon-digestion & Phenolate	FWPCA Methods Manual Nov. 1969
NH_3 - Nitrogen	Technicon-Sodium Phenolate	FWFCA Methods Manual Nov. 1969
Nitrate-Nitrite, Nitrogen	Technicon-Cadmium Reduction	FWPCA Methods Manual Nov. 1969
Total Phosphorus	Technicon - Manual digestion & automated single reagent	FWPCA Methods Manual Nov. 1969
Orthophosphate	Technicon - Single Reagent	FWPCA Methods Manual Nov. 1969
Organic Carbon (TOC)	Beckman Carbonaceous Analyzer	FWPCA Methods Manual Nov. 1969
Chemical Oxygen Demand (COD)	Dichromate Reflux - 0.25N	Standard Methods, 12th Edition
Chemical Oxygen Demand (COD)	Dichromate Reflux - 0.25N	FWPCA Methods Manual
Sulfide	Iodometric	Standard Methods,12th
Turbidity	Hach 2100 Turbidimeter	FWPCA Methods Manual
Chromium, Total	Atomic Absorption	FWPCA Methods Manual
Color	Platinum, Cobalt Visual	FWPCA Methods Manual
Suspended Solids, Total (Non-Filterable)	Glass-Fiber Filteration, 105°C	FWPCA Methods Manual

Analyses	Method	Reference
Volatile Suspended Solids	Gravimetric, 550°C	Standard Methods,12th Edition
Sediment Samples - All Analyses Based on Dry Weight		
Chemical Oxygen Demand	Dichromate Reflux 0.25N	Standard Methods,12th Edition
Organic Nitrogen	Manual Digestion and Distillation Technicon - Sodium Phenolate	FWPCA Methods Manual Nov. 1969
Total Phosphorus	Technicon - Manual Digestion & Automated Single Reagent	FWPCA Methods Manual Nov. 1969
Chromium, Hcl & HNO_3 Extractable	Hcl, HNO_3 digestion & Atomic Absorption	FWPCA Methods Manual Nov. 1969
Pesticides	Gas Chromotography using electron capture detector (extraction solvent 15 percent methylene chloride in hexane).	FWPCA Method for Chlorinated Hydrocarbon Pesticides on Water and Waste-Water April 1969

SAVANNAH RIVER PLANT

Sampling Station Description

UTR-1	Upper Three Runs Creek control station at SRP Road F bridge
UTR-2	Upper Three Runs Creek at South Carolina Highway 125 bridge
UTR-3	Upper Three Runs Creek 75 yards upstream from Savannah River
FMC-4	Four Mile Creek Control Station at culvert 4000 feet down dirt road from SRP Road E
FMC-5	Four Mile Creek at South Carolina Highway 125 bridge
FMC-6	Four Mile Creek 50 yards upstream from Savannah River
PB-7	Pen Branch control station at culvert 3000 feet down dirt road from SRP Road C
PB-8	Pen Branch at South Carolina Highway 125 bridge
ST-10	Steel Creek at South Carolina Highway 125 bridge
ST-11	Steel Creek 50 yards upstream from Savannah River
LTR-12	Lower Three Runs Creek Control Station at culvert 2000 feet down dirt road from SRP Road 8
LTR-13	Lower Three Runs Creek at South Carolina Highway 66 bridge

APPENDIX B

BACTERIAL WATER QUALITY
MIDDLE REACH OF THE SAVANNAH RIVER

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APPENDIX B

Bacterial Water Quality

By

B. J. Carroll and R. E. Gentry

INTRODUCTION

A comprehensive water quality survey of the middle reach of the Savannah River was conducted by the Technical Services Program, Southeast Water Laboratory, Environmental Protection Agency during the summer of 1970. The survey included the examination of water quality of the Savannah River and its major tributaries in Georgia and South Carolina. The bacterial water quality portion of this survey included the analysis for fecal coliform bacteria and qualitative examinations for Salmonella.

Waters receiving domestic, wildlife and/or livestock wastes are characterized by the presence of bacteria which normally inhabit the intestinal tracts of warm-blooded animals, including man. The coliform group is the most numerous group of bacteria found in human excreta. Several genera with similar biochemical properties comprise this group. Some genera occur naturally outside the intestinal tract, a fact that has caused objections to the use of this group as indicators of fecal pollution.

Many objections to using coliform bacteria as indicators of fecal pollution were overcome with the work of Clark, et al., (1), Geldreich, et al., (2), (3), and Geldreich (4). Advances resulting from these studies enhanced the differentiation of the coliform bacteria group into sub-groups of fecal and non-fecal origin. The fecal coliform bacteria group is presently the most reliable bacterial measure of fecal pollution. All bacteriological samples collected during this study were analyzed for fecal coliform bacteria.

Though generally considered non-pathogenic, coliforms are considered to indicate the probable presence of enteric pathogens. Some enteric pathogens and coliform bacteria found in polluted water, if ingested, may cause gastronenteritis, dysentery, typhoid fever, and/or paratyphoid fever. Although not necessarily related to enteric pathogens, ear, eye, nose, throat, and skin infections and/or irritations are commonly contracted from contact with polluted waters. Viral diseases, such as infectious hepatitis and polio, may also result from contact and ingestion of water receiving fecal wastes.

Perhaps the easiest of the enteric pathogens to isolate are members of the genus _Salmonella_. _Salmonella_ is a large serologically related genus comprised of some 1300 serotypes. All _Salmonella_ are considered pathogenic for man, animals, or both. They are discharged from an infected host by excretal discharges. The presence of _Salmonella_ in environmental waters is proof not only of fecal contamination but also conclusively establishes the potential for disease contraction resulting from water ingestion.

Summary

During the study period, July 6 to August 4, 1970 fecal coliform bacteria determinations were made on 312 samples collected at 82 stations. Qualitative examinations and identification of serotypes was made for members of the genus _Salmonella_ at 29 selected stations. The mean fecal coliform bacteria densities observed at the sampling stations ranged from < 20 to 73,000,000/100 ml. _Salmonella_ were recovered at 85 percent of the stations sampled, with a total of 27 different serotypes identified.

Mean fecal coliform bacteria contributions to the Savannah River from Georgia and South Carolina tributaries are:

Georgia

- Industrial Canal - 20,000/100 ml
- Butler Creek - 5,900,000/100 ml
- Spirit Creek - 800/100 ml

South Carolina

- Kelly Creek - 170,000/100 ml
- Little Horse Creek - 14,000/100 ml
- Horse Creek - 74,000/100 ml
- Lower Three Runs Creek - 230/100 ml.

Each of these tributaries receives fecal contamination from point sources or tributaries within their respective drainage basins.

Samples collected at both Augusta and North Augusta raw water intakes contained *Salmonella*. With the exception of the control station, *Salmonella* were detected at all Savannah River stations. The stations sampled span approximately 74 miles of stream.

Conclusions

1. The bacterial quality of the Savannah River is significantly degraded as it flows through the greater Augusta area. The adverse effect on bacterial quality results from the cumulative domestic and industrial wastes discharged directly to the Savannah River from Georgia and South Carolina and those transported via tributaries. As a result of waste discharges within the greater Augusta area, the bacterial criteria established for the Savannah River by the State of Georgia are violated for a minimum of 18 river miles.

2. Of the tributaries entering the Savannah River within the study area, Butler Creek (Georgia) appears to have the greatest detrimental effect on the bacterial quality of the river.

3. There must be some measure of standardization of bacterial standards for similar water-use classifications as they apply to stateline streams. If variance in permissable bacterial levels is allowed for each side of the same stream reach, only inequitable enforcement of standards can result. Such a standardization must be accomplished between the states of Georgia and South Carolina on the Savannah River.

Study Area

The study area includes the Augusta Standard Metropolitan Statistical Area (SMSA) (Richmond County, Georgia, and Aiken County, South Carolina), the AEC Savannah River Plant and adjacent industries located in Barnwell and Allendale Counties, South Carolina. The Augusta SMSA encompasses 1,410 square miles with a population of 393,000.

The interstate waters in the study area are classified by the respective states as to their water-use. With most classifications, fecal coliform bacteria levels are established to control the microbiological suitability of these waters. Both Georgia and South Carolina have established water-use classifications which contain permissable bacterial levels for the portion of the Savannah River in the study area. Both states have classified the river from Clarke Hill Dam to the 13th Street bridge in Augusta as a domestic raw water source. Under this classification, Georgia requires a monthly mean fecal coliform bacteria density not to exceed 5000/100 ml with not more than 5 percent of the samples during a 90-day period exceeding 20,000/100 ml (5). South Carolina requires an arithmetic monthly mean fecal coliform bacteria density of 2000/100 ml for the same reach of stream (6).

From the 13th Street bridge downstream to U. S. Highway 301 (approximately mile 129), Georgia classified this reach for fishing and fish propagation. Under this classification, Georgia requires a monthly mean fecal coliform bacteria level not to exceed 5000/100 ml, with not more than 5 percent of the samples during any 90-day period exceeding 20,000/100 ml. Downstream from U. S. Highway 301 to U. S. Highway 17 (approximately mile 22), Georgia has a classification of drinking water. This classification requires a monthly fecal coliform bacteria mean not to exceed 50/100 ml with not more than 5 percent of the samples exceeding 200/100 ml during any 90-day period.

From the 13th Street bridge to Upper Three Runs Creek (approximately mile 157), South Carolina has this reach of stream classified for fish propagation, industrial and agricultural usage. Under this classification, no bacterial criterion is recommended. From Upper Three Runs Creek to U. S. Highway 17 (approximately mile 22), South Carolina has the stream classified for domestic water supply. Under this classification, a monthly arithmetic mean fecal coliform bacteria level not to exceed 2000/100 ml is required for standard compliance.

STUDY FINDINGS

During the study period, from July 6 to August 4, 1970 fecal coliform bacteria (FC) analyses were made on 312 samples collected at 82 stations. Qualitative examinations were made for members of the genus Salmonella at 29 selected stations. Station locations and descriptions are contained in Table B-I. Results of FC analyses are contained in Table B-II and summarized in Table B-III. Figures B-1 through B-5 show the station locations and the mean FC densities at these stations.

I. Fecal Coliform Bacteria Results

A. Georgia Sources

1. Industrial Canal

A major portion of the canal flow enters the Savannah River through Hawk's Gully with a mean[1/] FC density of 20,000/100 ml as measured at station HG-4 (0.5 mile from confluence). Combined city sewers, located between stations SI-3 and HG-4, contribute most of the bacterial pollution to the canal. The control station, IC-1, was located above all defined waste sources, and had a mean FC density of 35/100 ml (Table B-III).

Some of the canal flow is diverted from Hawk's Gully to the Beaver Dam ditch system which drains into Butler Creek.

2. Butler Creek

Butler Creek discharged a mean FC density of 5,900,000/100 ml to the Savannah River as measured at station BC-6 (0.1 mile from confluence). Most bacterial pollution enters Butler Creek from Cason Dead River.

[1/] All mean values are geometric.

Cason Dead River receives drainage containing domestic, industrial, and storm water runoff from Oates Creek, Camille Street Ditch, Beaver Dam Ditch, and some of the industrial canal flow.

The Butler Creek STP, located 0.8 mile from confluence, discharged a mean FC density of 1,300/100 ml to Butler Creek.

The control station, BC-5 (located 2.5 miles from confluence) and a mean FC density of 480/100 ml indicating some fecal pollution above this point.

3. Spirit Creek

Spirit Creek contributed a mean FC density of 800/100 ml to the Savannah River as measured at station SC-11 (100 feet above confluence). The Ft. Gordon sewage treatment plant located approximately 17 miles above the confluence is the major contributor of fecal waste to Spirit Creek. The plant effluent, station FG-8, had a mean FC density of 1,500,000/100 ml. Natural purification processes greatly reduce the FC density in Spirit Creek by the time its flow enters the Savannah River.

B. South Carolina Sources

1. Horse Creek Drainage

a. Kelly Creek

Kelly Creek contributed a mean FC density of 170,000/100 ml to Horse Creek as measured at station KC-24 (0.4 mile above confluence). The major sources of bacterial pollution are the Aiken and Warrenville sewage treatment plant effluents. The Aiken STP effluent, station A-36, (2.8 miles above confluence) discharged a mean FC density of 7,400,000/100 ml. The Warrenville STP effluent, station W-37, (0.5 mile above confluence) discharged a mean FC density of 2,800,000/100 ml. The control station, KC-21, (3.0 miles above confluence) had a mean FC density of 190/100 ml.

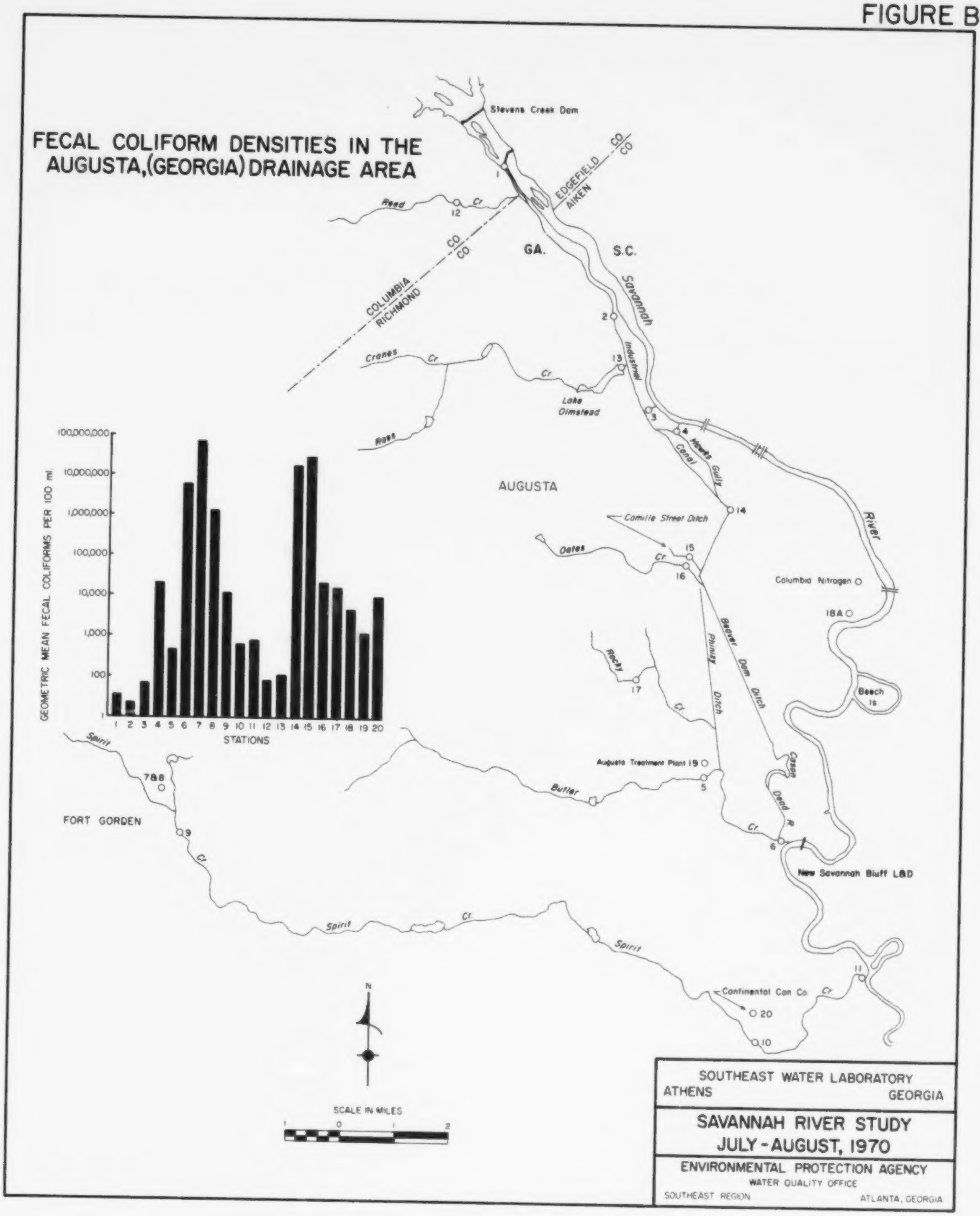
b. Little Horse Creek

Little Horse Creek contributed a mean FC density of 14,000/100 ml to Horse Creek as measured at station LHC-33 (0.1 mile above confluence). The only defined waste sources on Little Horse Creek are the Clearwater Finishing Plant and the Seminole Mills. The Clearwater Finishing Plant (0.3 mile above confluence) discharged an effluent with a FC density of <20/100 ml. The Seminole Mill has two effluents discharging into Little Horse Creek, of which only one was accessible for sampling. This effluent, station SM-39, had a mean FC density of 340/100 ml. The inaccessible effluent discharges raw domestic waste which was the major source of the high FC density at station LHC-33. The control station LHC-31 (1.7 miles above confluence) had a mean FC density of 630/100 ml, indicating some fecal pollution from an undefined source.

c. Horse Creek

Horse Creek contributed a mean FC density of 74,000/100 ml to the Savannah River as measured at station HC-35 (1.6 miles above confluence). The major sources of bacterial pollution enter Horse Creek via Kelly Creek and Little Horse Creek. Several mills contribute some bacterial pollution to Horse Creek. The Bath Mill, station B-38, (4.6 miles above confluence), discharged waste with a mean FC density of 970/100 ml. The Valchem plant, station V-28, (6.6 miles above confluence) discharged waste with a mean FC density of 780/100 ml. The Graniteville Textile Mill, station GM-26, (10.0 miles above confluence) discharged waste with a FC density of <20/100 ml. The reduced FC densities in Horse Creek below this station suggest a toxic waste was being discharged. The control station, HC-25, (10.5 miles above confluence) had a mean FC density of 220/100 ml.

FIGURE B-1



FECAL COLIFORM DENSITIES IN THE AUGUSTA,(GEORGIA) DRAINAGE AREA

Stevens Creek Dam
EDGEFIELD CO
AIKEN CO
COLUMBIA CO
RICHMOND CO
GA.
S.C.
Reed Cr
Savannah
River
Cranes Cr
Rocks
Lake Olmstead
Industrial Canal
Hawks Gully
AUGUSTA
Camille Street Ditch
Oates Cr
Columbia Nitrogen
18A
Beech Is
Rocky Cr
Phinizy Ditch
Beaver Dam Ditch
Augusta Treatment Plant 19
Butler
Cason
Dead R.
New Savannah Bluff L&D
Spirit Cr
7&8
FORT GORDEN
Continental Can Co
1
2
3
4
5
6
9
10
11
12
13
14
15
16
17
20
N
SCALE IN MILES
1 0 1 2
GEOMETRIC MEAN FECAL COLIFORMS PER 100 ml.
100,000,000
10,000,000
1,000,000
100,000
10,000
1,000
100
1
STATIONS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

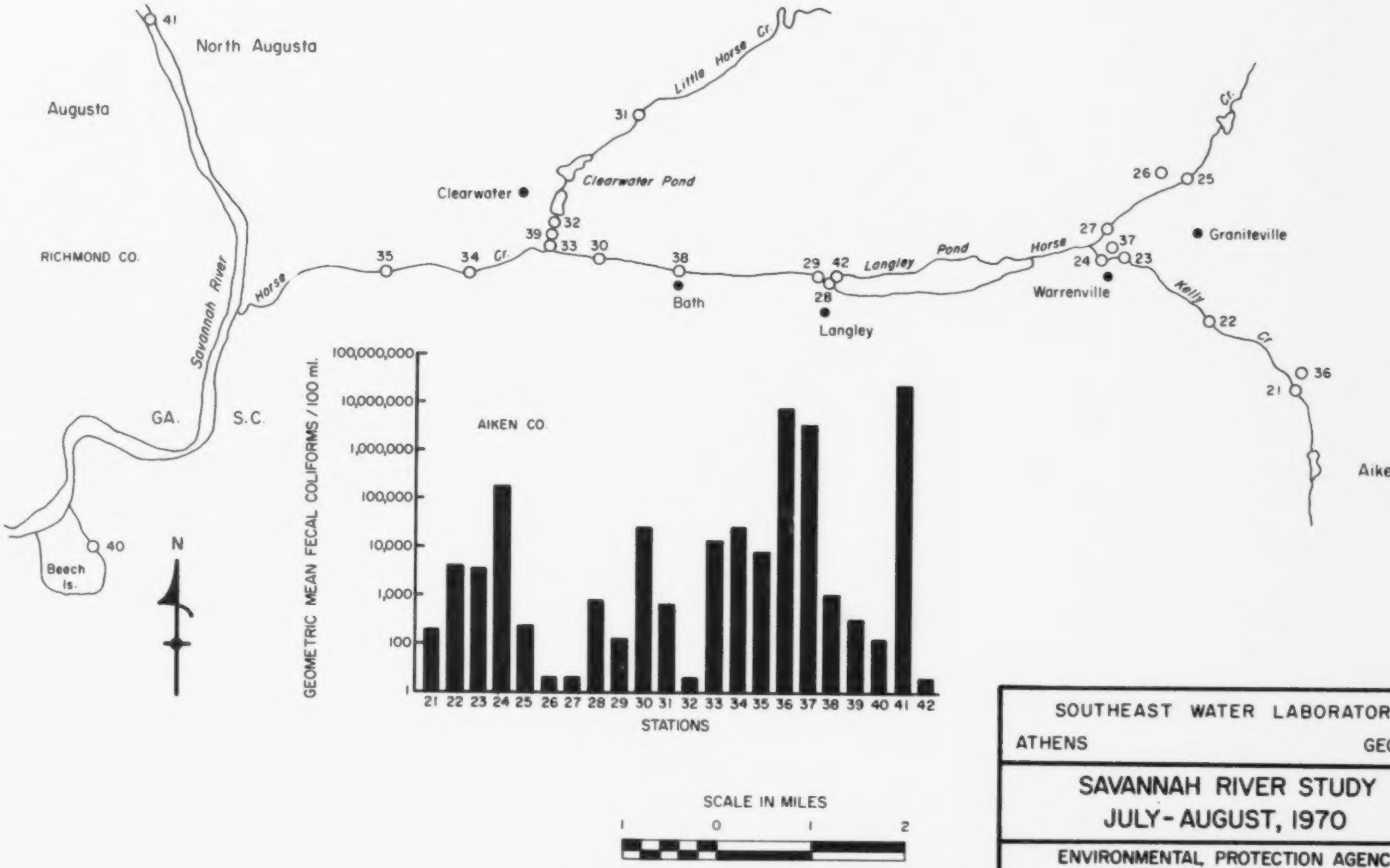
SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY - AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

FIGURE B-2

FECAL COLIFORM DENSITIES IN THE HORSE CREEK, (SOUTH CAROLINA) DRAINAGE AREA


41
North Augusta
Augusta
RICHMOND CO.
Savannah River
Horse
GA.
S.C.
40
Beech Is.
N
35
34
Cr.
39
33
32
30
Clearwater
Clearwater Pond
31
Little Horse Cr.
38
Bath
29
28
42
Langley
Langley
Pond
Horse
27
26
25
Cr.
Graniteville
37
24
23
Warrenville
Kelly
22
Cr.
36
21
Aiken
AIKEN CO.
GEOMETRIC MEAN FECAL COLIFORMS / 100 ml.
100,000,000
10,000,000
1,000,000
100,000
10,000
1,000
100
1
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
STATIONS
SCALE IN MILES
1
0
1
2

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY-AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

2. Lower Three Runs Creek

Lower Three Runs Creek contributed a mean FC density of 230/100 ml to the Savannah River as measured at station LTR-46 (100 feet above confluence). The only defined bacterial pollution source entering Lower Three Runs Creek is the J. P. Stevens Plant. This effluent, station JPS-44, had a mean FC density of 6,900,000/100 ml. The effect of this high FC density waste was not reflected in the FC density at station LTR-46. The control station LTR-43 (6.7 miles above confluence) had a mean FC density of 66/100 ml.

C. Savannah River - Augusta City Dam (mile 207.5) to below Spirit Creek (mile 182.6)

Figure 4 shows the mean FC densities at the stations in this reach of the stream. Figure 6 shows the average daily FC discharges entering this reach during the study period.

Station S-50, located immediately upstream of the Augusta Dam, serves as a control station for the Savannah River within the study area. The bacterial quality of the stream at this point was good, as was reflected by a mean FC density of 35/100 ml. Compliance with both the Georgia and South Carolina bacterial standards is easily attained at this point. This good quality water extends downstream some five miles, where at station S-73 the mean FC density was 44/100 ml.

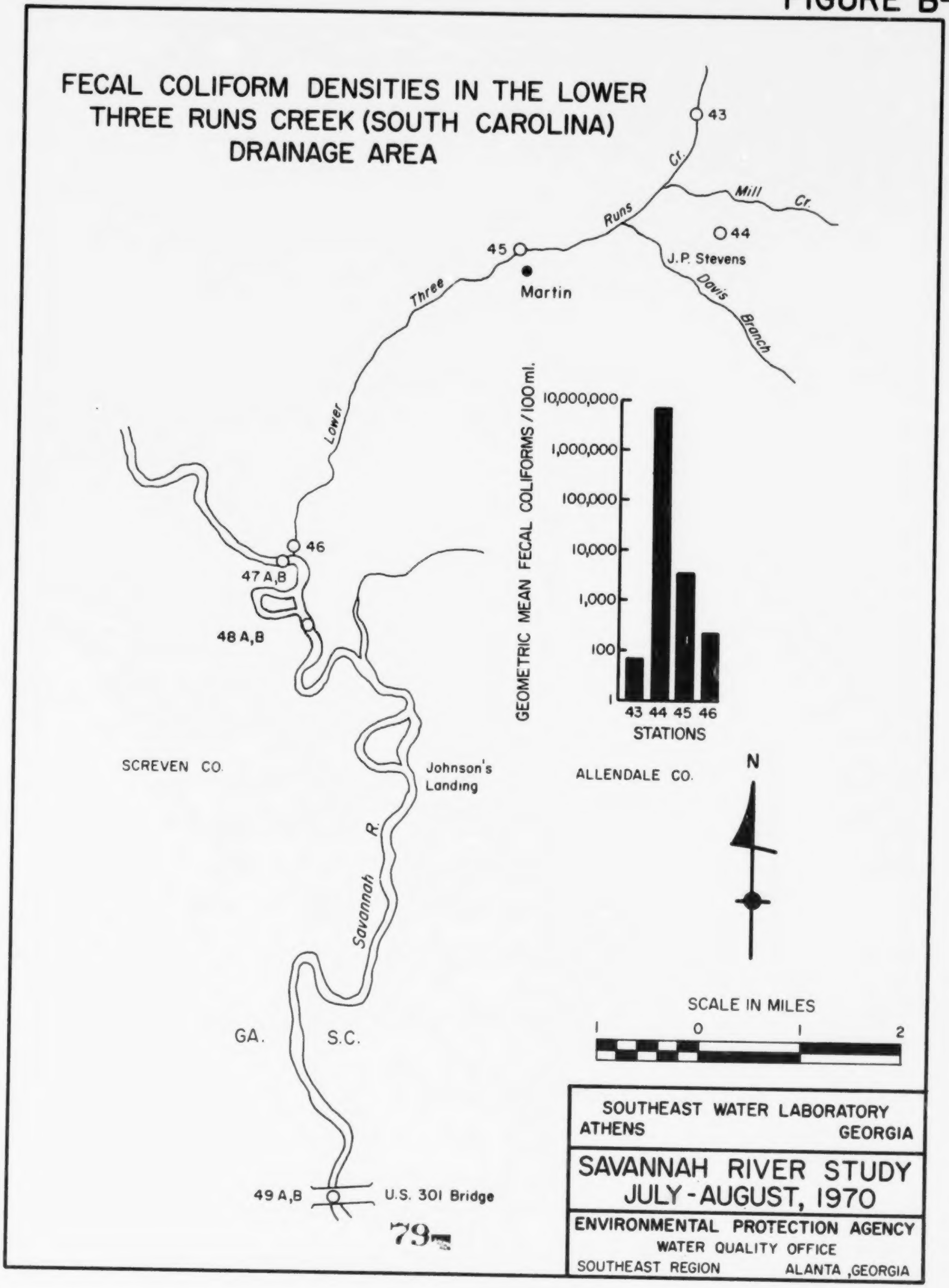
The first major source of bacterial pollution entering the Savannah River is the industrial canal (mile 201.2) which discharged 503 mgd with a mean FC density of 20,000/100 ml. Some 0.5 mile downstream, North Augusta, South Carolina, discharges raw sewage (.95 mgd) with a mean FC density of 21,000,000/100 ml (NA-41) into the Savannah River.

The cumulative effect of these waste sources on the bacterial quality of the Savannah River was observed at stations 74A and 74E which are located approximately 0.1 mile downstream from the North Augusta outfall. At these stations, the mean FC densities were 29,000/100 ml and 12,000/100 ml for the Georgia and South Carolina sides, respectively.

As a result of these discharges, the bacterial criteria established for these waters by the State of Georgia are violated. The established State standards continue to be violated for approximately the next 18 miles on the Georgia side of the Savannah River. The inability to comply with the standards in this reach of stream is further complicated by additional waste input downstream.

Approximately three miles downstream of S-74, the mean FC density on the Georgia side remained at 29,000/100 ml, as a result of the waste discharge from the City of Augusta's Second Street outfall. On the South Carolina side there was a reduction in mean FC density to 7,500/100 ml as measured at station S-53. This station is located approximately 0.1 mile above the confluence of Horse Creek with the Savannah River.

FIGURE B-3



FECAL COLIFORM DENSITIES IN THE LOWER THREE RUNS CREEK (SOUTH CAROLINA) DRAINAGE AREA

43
Cr.
Mill Cr.
Runs
44
45
J.P. Stevens
Davis Branch
Three
Martin
Lower
46
47 A,B
48 A,B
GEOMETRIC MEAN FECAL COLIFORMS / 100 ml.
10,000,000
1,000,000
100,000
10,000
1,000
100
1
43 44 45 46
STATIONS
SCREVEN CO.
Johnson's Landing
ALLENDALE CO.
N
Savannah R.
SCALE IN MILES
1 0 1 2
GA.
S.C.
49 A,B
U.S. 301 Bridge
SOUTHEAST WATER LABORATORY
ATHENS GEORGIA
SAVANNAH RIVER STUDY
JULY - AUGUST, 1970
ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ALANTA ,GEORGIA

Horse Creek, the first major tributary entering the Savannah River from South Carolina within the study area, discharged 103 mgd with a mean FC density of 7,400/100 ml. Although this stream receives significant bacterial pollution upstream, the magnitude of this waste is not reflected in the mean FC density discharged into the Savannah River. The bacterial quality of the river is not appreciably effected by this discharge. Station S-77, located approximately 0.3 mile below Horse Creek, was characterized by a mean FC density on the South Carolina side of 8,000/100 ml.

The next defined waste source, Butler Creek, enters on the Georgia side at mile 187. Butler Creek discharged 54 mgd with a mean FC density of 5,900,000/100 ml. Immediately upstream of the confluence of Butler Creek at station S-58, the mean FC levels of 11,000 and 16,000/100 ml on the Georgia and South Carolina sides, respectively, indicated a generally well-mixed situation. The impact of the Butler Creek discharge was evidenced at station S-83, approximately 0.3 mile below Butler Creek. The mean FC densities measured were 160,000/100 ml, 62,000/100 ml, and 20,000/100 ml for the Georgia side, midstream, and South Carolina side, respectively. Of the tributaries entering the Savannah River within the study area, Butler Creek had the greatest detrimental effect on the bacterial quality of the river.

Spirit Creek enters the Savannah approximately 4.2 miles downstream of the Butler Creek confluence. At station S-86, approximately 0.2 mile above Spirit Creek, the mean FC densities were 44,000/100 ml and 93,000/100 ml on the Georgia and South Carolina sides, respectively. The reduced FC density on the Georgia side possibly resulted from the toxic effect of chlorine discharged to the river by the Olin Corporation.

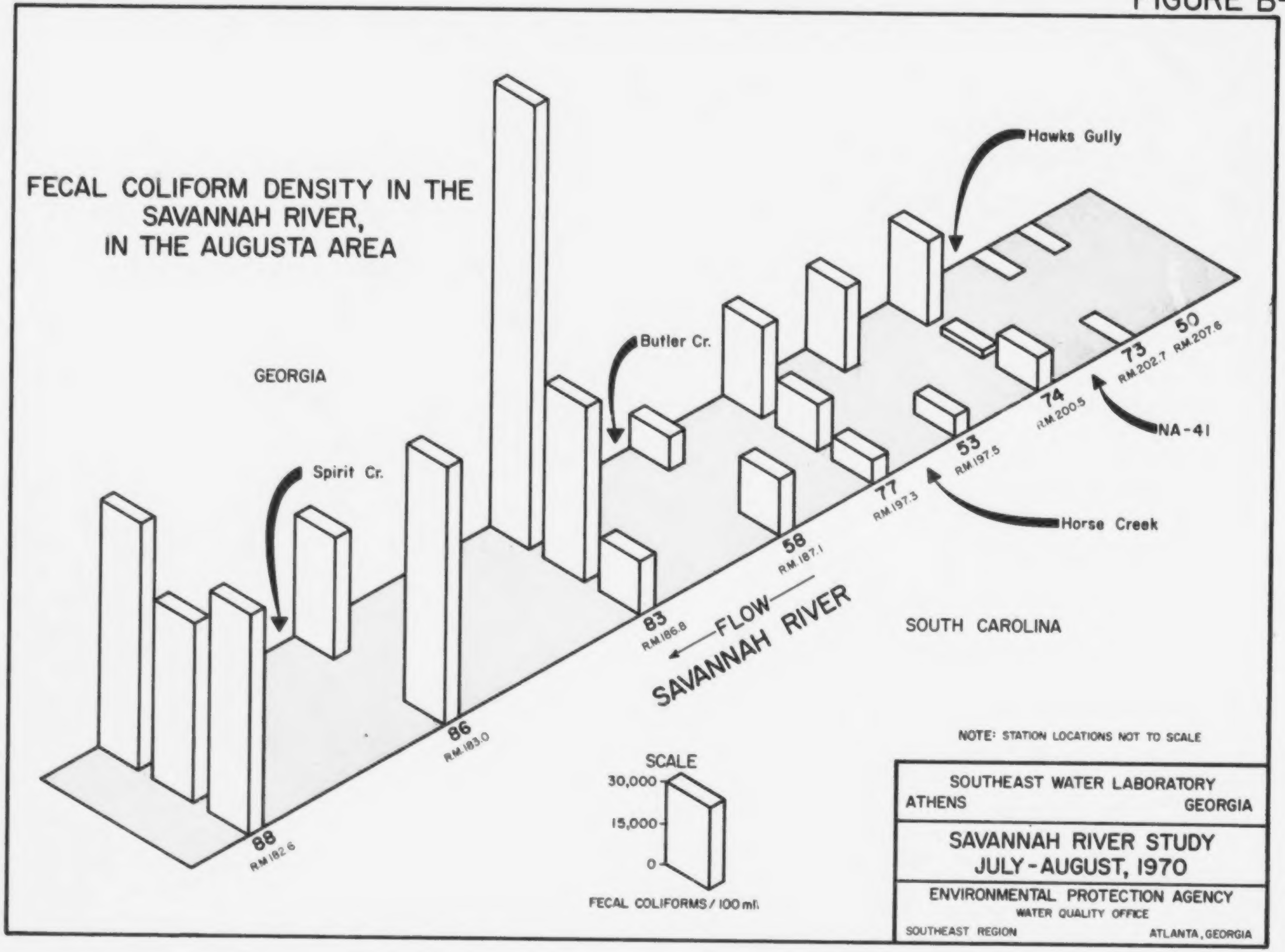
Spirit Creek discharged 65 mgd with a mean FC density of 800/100 ml. Station S-88, located 0.2 mile downstream of the confluence, had mean FC densities of 89,000/100 ml, 64,000/100 ml, and 79,000/100 ml on the Georgia side, midstream, and South Carolina side, respectively. A comparison of the densities above and below the Spirit Creek confluence suggested that Spirit Creek caused an increased indicator level in the river. Based on the low level of indicators being discharged together with the levels across the river below the confluence, it appears that mixing which occurs between stations S-86 and S-88 may account for this increase, rather than the discharge itself.

The next station located on the Savannah River is approximately 53 miles downstream.

D. Savannah River - In the Lower Three Runs Creek Area

Station S-47, located approximately 500 yards above the confluence of Lower Three Runs Creek, had mean FC densities of 2,000/100 ml and 1,900/100 ml on the Georgia and South Carolina sides, respectively. These densities indicated a partial recovery of the river from the bacterial pollution of the greater Augusta area and was also indicative of a well-mixed condition. Lower Three Runs Creek enters the Savannah with a mean FC density of 230/100 ml, as measured at station LTR-46. Generally, Lower Three Runs Creek does not adversely affect the bacterial quality of the river as shown by the FC densities measured at station S-66. The mean FC densities measured were 1,100 and 1,200/100 ml for the Georgia and South Carolina sides, respectively. However, within the immediate area of the confluence of Lower Three Runs Creek, drainage from surrounding swamp lands possibly results in the elevation of bacterial indicator levels measured at stations S-67, S-68, S-69, S-70, and S-71, Figure 5.

FIGURE B-4



FECAL COLIFORM DENSITY IN THE SAVANNAH RIVER, IN THE AUGUSTA AREA

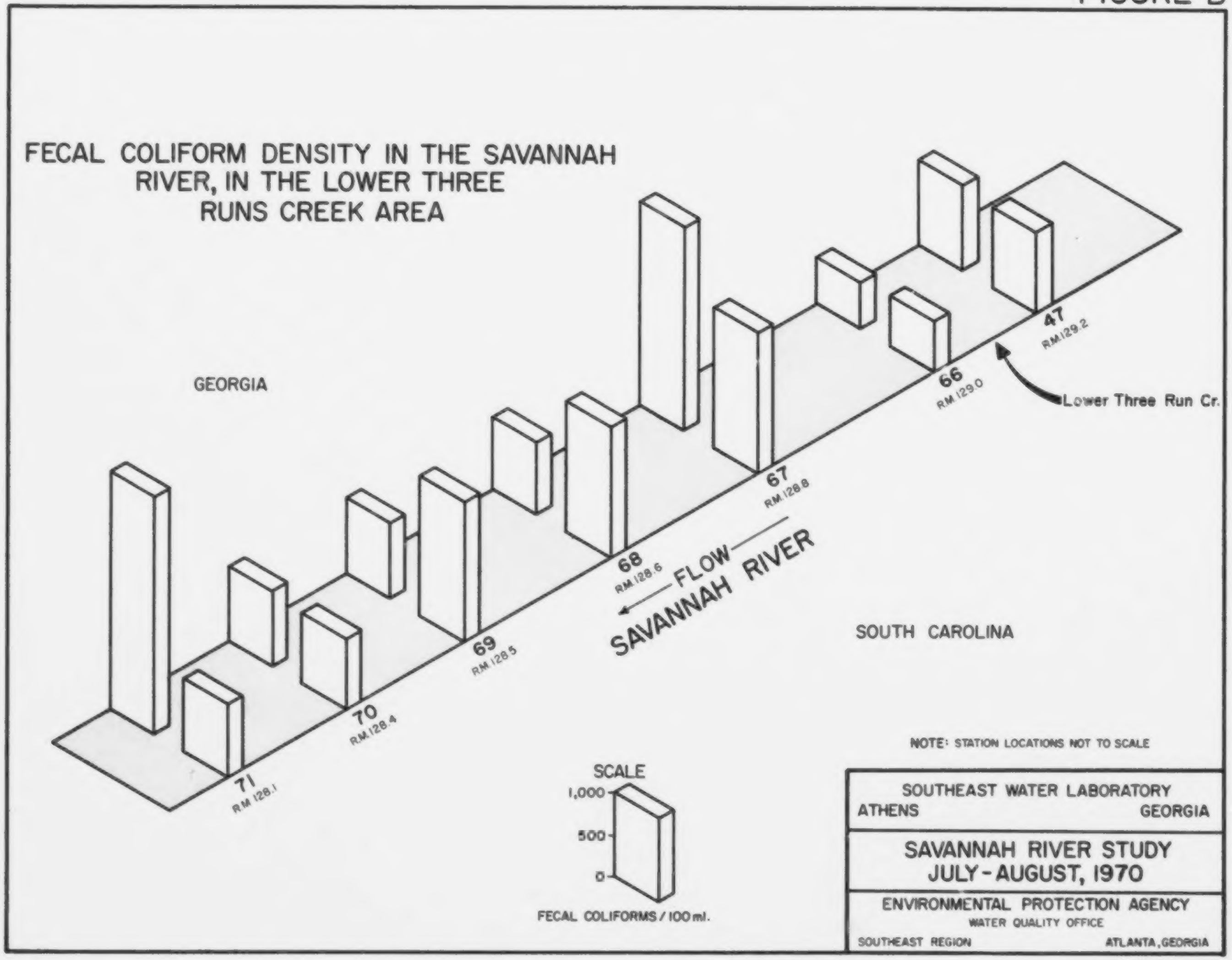
NOTE: STATION LOCATIONS NOT TO SCALE

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY - AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

FIGURE B-5



FECAL COLIFORM DENSITY IN THE SAVANNAH RIVER, IN THE LOWER THREE RUNS CREEK AREA

NOTE: STATION LOCATIONS NOT TO SCALE

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY - AUGUST, 1970

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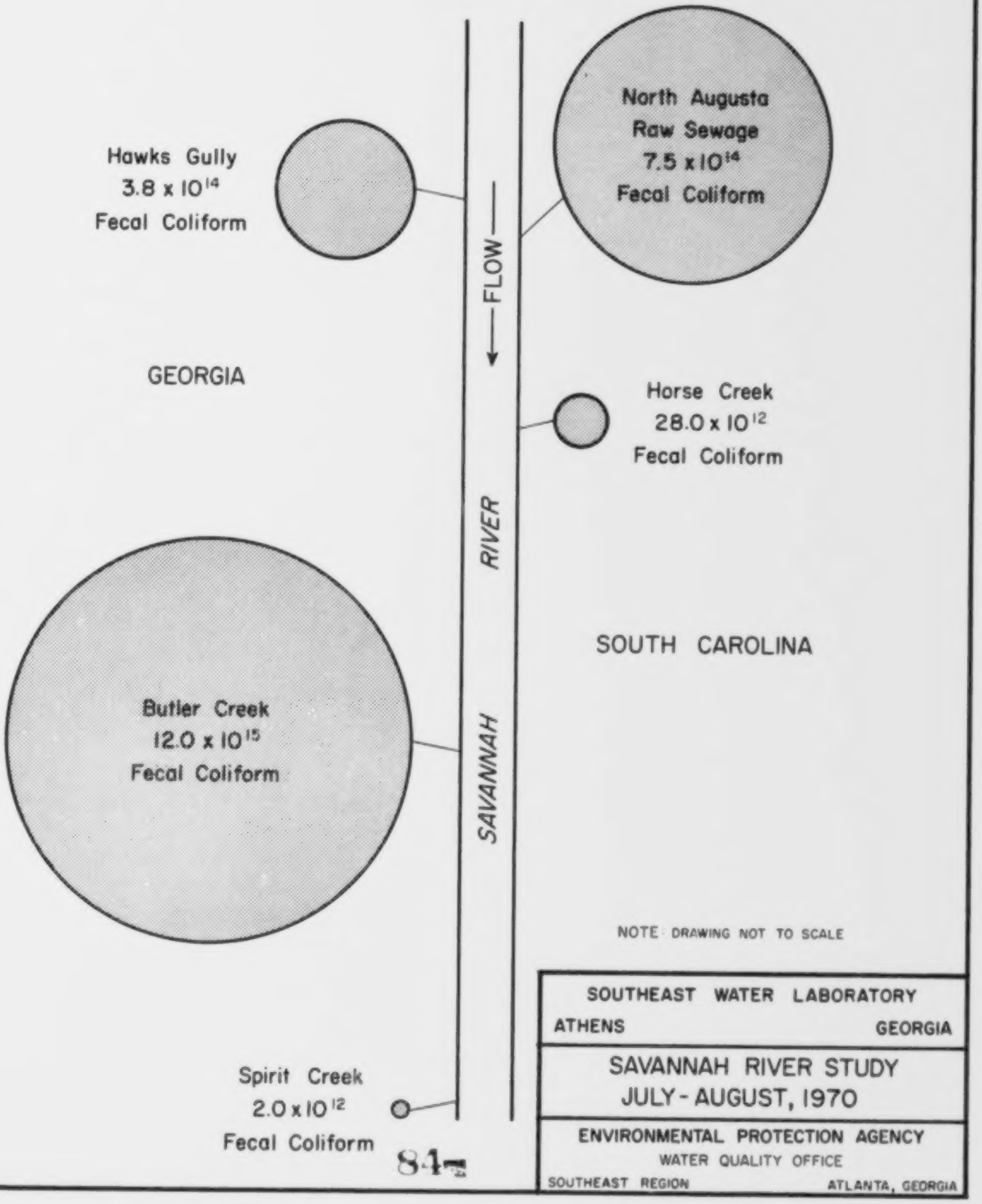
FIGURE B-6

AVERAGE DAILY FECAL COLIFORM DISCHARGES TO THE SAVANNAH RIVER FROM THE MAJOR WASTE SOURCES


North Augusta
Raw Sewage
7.5 x 10^14
Fecal Coliform
Hawks Gully
3.8 x 10^14
Fecal Coliform
FLOW
GEORGIA
Horse Creek
28.0 x 10^12
Fecal Coliform
SAVANNAH RIVER
SOUTH CAROLINA
Butler Creek
12.0 x 10^15
Fecal Coliform
NOTE: DRAWING NOT TO SCALE
Spirit Creek
2.0 x 10^12
Fecal Coliform
SOUTHEAST WATER LABORATORY
ATHENS GEORGIA
SAVANNAH RIVER STUDY
JULY - AUGUST, 1970
ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

II. *Salmonella* in Waters Studied

In addition to the determination of fecal coliform bacteria densities within the study area, special efforts were made to detect members of the genus *Salmonella* at selected sites. The relative density of an indicator is generally viewed to indicate the relative magnitude of wastes being discharged. Moreover, as the indicator level increases, so does the probability of enteric pathogen presence increase. The one undeniable fact is that if the pathogen is isolated at a sampling site, the disease producing capacity of this water is established.

The ten most frequently isolated *Salmonella* from both human and non-human sources for July, 1970, are shown in Table B-IV(12). Of the top ten isolates from human sources, seven were isolated during this study. These were *S. typhimurium* (including variety *copenhagen*), *S. newport*, *S. heidelberg*, *S. saint paul*, *S. thompson*, *S. derby*, and *S. montevideo*. Of the top ten isolates from non-human sources, five were among the isolates of this study. These were *S. typhimurium* (including variety *copenhagen*), *S. heidleberg*, *S. anatum*, *S. saint paul*, and *S. montevideo*.

A total of 27 different *Salmonella* serotypes were isolated during the study; these are listed according to station locations in Table B-V. Of the sites where *Salmonella* detection was attempted, 85 percent were found to be positive for these organisms; see Table B-V.

A comparison of fecal coliform levels with the presence of Salmonella is shown in Table B-VI. As illustrated by these data, Salmonella were isolated on occasions when mean FC densities were 24 and 43/100 ml, and not isolated when the mean FC densities were 14,000 and 6,900,000/100 ml. The inability to isolate Salmonella at the higher FC levels does not infer the insignificance of the FC group as indicators of fecal contamination. Rather, the inability to isolate Salmonella at the higher FC densities possibly results from analytical inadequacies (swab technique), sporatic discharge of these pathogens, availability of host animals, or a combination of these factors. The failure to isolate Salmonella at relatively high FC densities have been observed by numerous workers (13) (14) (15).

The isolation of Salmonella at low FC densities, <100/100 ml was observed during this study. Similar observations have been made by other investigators (14) (16). Although the low FC densities are not reflective of significant fecal contamination, the isolation of Salmonella at these low levels establish the disease-producing capacity of these waters. The source of these organisms, although not defined, could be due to an endemic animal population of an area.

The recovery of Salmonella at sites where the FC densities were very low simply underscores the fact that low indicator values alone does not negate the possibility of pathogen presence.

Salmonella were isolated from each tributary stream entering the Savannah River, with the exception of Lower Three Runs Creek. All Savannah River stations, except for the control station (S-50), were positive for Salmonella.

Both the Augusta and North Augusta raw water intakes were positive for *Salmonella*. At the Augusta intake, *S. muenchen*, *S. mississippi*, and *S. give* were isolated, while at the North Augusta intake, *S. newport* and *S. panama* were detected. Both water intakes are located above any defined wastes discharges which would suggest a possible animal source for these pathogens. The presence of these organisms at the water intakes emphasizes the necessity of maintaining adequate water treatment practices together with continuous bacterial monitoring of the finished waters to avoid transmission of these organisms in the public water supply.

The isolation and identification of *Salmonella* at each of the Savannah River stations between station S-73A and station S-70A indicated approximately 74 miles of this stream could be potentially hazardous for water contact activities. The fact that *Salmonella* were recovered at 85 percent of the stations sampled and that 27 different serotypes were identified establishes the magnitude and, to a degree, the variety of sources of the fecal pollution in the area.

SAMPLING PROCEDURES AND METHODOLOGY

Sampling

All samples analyzed for indicator bacteria were collected at or near the surface using selected grab techniques. The samples were collected in sterile glass containers and placed on ice until time of analysis. Most samples were analyzed within six hours of collection.

In the case of some stream stations, left and right bank and mid-stream samples were collected. Left and right banks were designated by facing downstream. The sampling regime was dictated by both the physical characteristics of the stream and available waste source information. Most of the stations were sampled on several different days, although not necessarily on consecutive days. Samples were collected to reflect variable stream flows and diel bacterial variations. Some composite samples were collected.

Samples collected for the purpose of isolating *Salmonella* were obtained using a modification of the swab technique of Moore (7). Sanitary napkins (swabs) were folded, gauze ends tied together, and a length of heavy string was attached. The swabs were then wrapped in heavy kraft paper and sterilized. The sterile swabs were suspended just beneath the water surface at selected sampling stations. After 3-5 days, the swabs were retrieved, placed in sterile plastic bags, and returned to the laboratory for analysis.

Bacteriological Examination

Fecal coliform bacteria enumeration: The fecal coliform procedure outlined in Standard Methods (8) for the MPN multiple tube dilution was used. The procedure employs the standard presumptive test using Lauryl Tryptose Broth followed by fecal coliform confirmation using E. C. Medium at an elevated temperature (44.5° ± 0.5°C, waterbath).

Salmonella isolation and identification: Swabs used for isolation purposes were placed into wide-mouth jars containing approximately 200 ml of 1-1/2 strength Tetrathionate Broth with brilliant green added (1:100,000 w/v). The inoculated enrichment was incubated from 18 to 24 hours at 41.5°C according to the procedure of Spino (9). Some of the primary Brilliant Green Tetrathionate (BGT) enrichments were subcultured to SBG Sulfa Enrichment medium and incubated an additional 18-24 hours at 35°C. After either primary of subculture enrichment and inoculum from each enrichment was streaked onto Bismuth Sulfite Agar (BS), XLBG Agar, Taylor (XLBG) and Hektoen Enteric Agar (HE) plates and incubated at 35°C for 18-36 hours. Suspected Salmonella colonies were picked from the respective plates and subjected to the identification scheme outlined in Table B-VII.

The methods and media outlined in Table B-VII are described by Ewing (10), with the exception of the cytochrome oxidase and lysine decarboxylase methods. Oxidase and decaroxylase activity was determined using Patho-Tec-CO[1/] and Patho-Tec-LD[1/] reagent impregnated paper strips, respectively.

[1/] Does not imply endorsement of these products.

Definitive serological identification of Salmonella isolates was made at the Southeast Water Laboratory. The methodology used was the standard serological procedures described by Edwards and Ewing (11). Verification of these identifications was made by the Enteric Bacteriology Unit of the National Center for Disease Control, Atlanta.

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TABLE B-I

SAMPLING STATION LOCATIONS AND DESCRIPTIONS

Station Number	Station Description
IC-1	Industrial Canal at draw-off point from Savannah River north of Agusta.
IC-2	Industrial Canal at Augusta water intake.
S1-3	Water supply intake from Industrial Canal for Sibley textile mill.
HG-4	Hawks Gully outlet from Industrial Canal to the Savannah River at Broad Street bridge just north of 15th Street.
BC-5	Butler Creek from New Savannah Road bridge.
BC-6	Butler Creek from bridge in Corps of Engineer park upstream of confluence with Savannah River.
FG-7	Influent to Ft. Gordon sewage treatment plant.
FG-8	Effluent from Ft. Gordon sewage treatment plant.
SC-9	Spirit Creek from U. S. 1 bridge.
SC-10	Spirit Creek from Old Savannah Road bridge (Ga. 56).
SC-11	Spirit Creek upstream of confluence with Savannah River.

TABLE B-I cont'd

SAMPLING STATION LOCATIONS AND DESCRIPTIONS

Station Number	Station Descriptions
Intermittent Samples Collected:	
RC-12	Reed Creek from Stevens Creek Road culvert.
LO-13	Lake Olmstead drainage to Industrial Canal at Lake Shore Loop extension.
G-14	Gwinnet Street drainage ditch to Beaver Dam Ditch.
U-15	Unnamed ditch near Shapiro Packing Company from New Savannah Road culvert.
OC-16	Oates Creek at New Savannah Road culvert.
RO-17	Rocky Creek at New Savannah Road bridge.
CN-18	Columbia Nitrogen caprolactum plant effluent.
CN-18a	Columbia Nitrogen (Nitrogen plant effluent).
BC-19	Butler Creek sewage treatment plant effluent.
CC-20	Continental Can paper mill effluent.
KC-21	Kelly Creek at Dibble Road bridge upstream of Aiken sewage treatment plant effluent.

TABLE B-I cont'd

SAMPLING STATION LOCATIONS AND DESCRIPTIONS

Station Number	Station Descriptions
KC-22	Kelly Creek at Highway 421 culvert downstream of Aiken effluent.
KC-23	Kelly Creek at road leading to Warrenville sewage treatment plant upstream of effluent.
KC-24	Kelly Creek at Highway 81 bridge downstream of Warrenville effluent.
HC-25	Horse Creek on Highway 33 bridge upstream of Graniteville textile mill.
HC-27	Horse Creek at Highway 104 bridge downstream of Graniteville effluent.
HC-29	Horse Creek at Highway 254 bridge near Langley and upstream of inflowing branch.
HC-30	Horse Creek at Highway 421 bridge downstream of Bath.
HC-34	Horse Creek at Highway 145 bridge upstream of kaolin mining activity.
HC-35	Horse Creek at Highway 125-278 bridge.
LP-42	Overflow from Langley Pond on Horse Creek upstream of Valchem effluent.

TABLE B-I cont'd

SAMPLING STATION LOCATIONS AND DESCRIPTIONS

Station Number	Station Descriptions
LHC-31	Little Horse Creek on Highway 67 bridge upstream of Clearwater Finishing Plant effluent.
LHC-33	Little Horse Creek at Highway 421 bridge downstream of effluents.
GM-26	Effluent from Graniteville textile mill.
V-28	Effluent from the Valchem plant.
CM-32	Clearwater Finishing Plant effluent.
A-36	Aiken sewage treatment plant.
W-37	Warrenville sewage treatment plant effluent.
B-38	Bath Mill effluent.
SM-39	Seminole Mill effluent.
KC-40	Kimberly-Clark effluent.

TABLE B-I cont'd

SAMPLING STATION LOCATIONS AND DESCRIPTIONS

Station Number	Station Description
NA-41	North Augusta sewer outfall at 13th Street.
LTR-43	Lower Three Runs Creek in the vicinity of Highway 66 bridge.
LTR-45	Lower Three Runs Creek at Highway 125 bridge.
LTR-46	Lower Three Runs Creek 100 feet above confluence with the Savannah River.
JPS-44	J. P. Stevens textile mill effluent.
S-50-A[1]	Savannah River at Augusta City Dam near entrance to Industrial Canal north of Augusta, left bank.
S-73A	Savannah River at North Augusta water intake, left bank.
S-73E[2]	Savannah River at North Augusta water intake, right bank.
S-74A	Savannah River approximately 200 yards south of 13th Street bridge in Augusta, left bank.

---

[1] A - left bank (South Carolina side) facing downstream

[2] E right bank (Georgia side) facing downstream

TABLE B-I cont'd

SAMPLING STATION LOCATIONS AND DESCRIPTIONS

Station Number	Station Description
S-74C[3]	Savannah River approximately 200 yards south of 13th Street bridge in Augusta, mid-stream.
S-74E	Savannah River approximately 200 yards south of 13th Street bridge in Augusta, right bank.
S-53-A	Savannah River approximately 200 yards upstream of Horse Creek, left bank.
S-53E	Savannah River approximately 200 yards upstream of Horse Creek, right bank.
S-77A	Savannah River approximately 300 yards below mouth of Horse Creek, left bank.
S-77C	Savannah River approximately 300 yards below mouth of Horse Creek, right bank.
S-77E	Savannah River approximately 300 yards below mouth of Horse Creek, right bank.
S-58A	Savannah River approximately 100 yards upstream of Butler Creek and below New Savannah Bluff lock and dam, left bank.
S-58E	Savannah River approximately 100 yards upstream of Butler Creek and below New Savannah Bluff lock and dam, right bank.

---

[3] C - Midstream

TABLE B-I cont'd

SAMPLING STATION LOCATIONS AND DESCRIPTIONS

Station Number	Station Description
S-83A	Savannah River at boat ramp approximately 300 yards below mouth of Butler Creek, left bank.
S-83C	Savannah River at boat ramp approximately 300 yards below mouth of Butler Creek, mid-stream.
S-83E	Savannah River at boat ramp approximately 300 yards below mouth of Butler Creek, right bank.
S-86A	Savannah River just downstream of channel marker # 87 and approximately 300 yards above mouth of Spirit Creek, left bank.
S-86E	Savannah River just downstream of channel marker # 87 and approximately 300 yards above mouth of Spirit Creek, right bank.
S-88A	Savannah River Approximately 300 yards below mouth of Spirit Creek, left bank.
S-88C	Savannah River approximately 300 yards below mouth of Spirit Creek, midstream.
S-88E	Savannah River approximately 300 yards below mouth of Spirit Creek, right bank.

TABLE B-I cont'd

SAMPLING STATION LOCATIONS AND DESCRIPTIONS

Station Number	Station Description
S-47A	Savannah River at channel marker # 48 approximately 500 yards above the mouth of Lower Three Runs Creek, left bank.
S-47E	Savannah River at channel marker # 48 approximately 500 yards above the mouth of Lower Three Runs Creek, right bank.
S-66A	Savannah River approximately 100 yards below mouth of lower Three Runs Creek, left bank.
S-66E	Savannah River approximately 100 yards below mouth of Lower Three Runs Creek, right bank.
S-67A	Savannah River approximately 300 yards below mouth of Lower Three Runs Creek, left bank.
S-67E	Savannah River approximately 300 yards below mouth of Lower Three Runs Creek, right bank.
S-68A	Savannah River approximately 500 yards below mouth of Lower Three Runs Creek, left bank.
S-68E	Savannah River approximately 500 yards below mouth of Lower Three Runs Creek, right bank.
S-69A	Savannah River approximately 700 yards below mouth of Lower Three Runs Creek, left bank.

TABLE B-I cont'd

SAMPLING STATION LOCATIONS AND DESCRIPTIONS

Station Number	Station Description
S-69E	Savannah River approximately 700 yards below mouth of Lower Three Runs Creek, right bank.
S-70A	Savannah River approximately 1000 yards below mouth of Lower Three Runs Creek, left bank.
S-70E	Savannah River approximately 100 yards below mouth of Lower Three Runs Creek, right bank.
S-71A	Savannah River approximately 1500 yards below mouth of Lower Three Runs Creek, left bank.
S-71E	Savannah River approximately 1500 yards below mouth of Lower Three Runs Creek, right bank.

TABLE B-II

DAILY FECAL COLIFORM BACTERIA DENSITIES AT ALL STATIONS SAMPLED

Location	Station Number	Fecal Coliform Bacteria/100 ml				
		7/6/70	7/7/70	7/8/70	7/9/70	7/10/70
Industrial Canal	IC-1	20	20	130	50	20
Industrial Canal	IC-2	20	20	20	50	20
Industrial Canal	SI-3	230	70	330	50	20
Industrial Canal	HG-4	23,000	17,000	46,000	23,000	7,900
Butler Creek	BC-5	790				
Butler Creek	BC-6	17,000,000	7,900,000	4,900,000	3,300,000	3,300,000
Ft. Gordon STP Influent	FG-7 AM FG-7 PM	110,000,000 110,000,000	70,000,000 79,000,000	33,000,000 ---	70,000,000 ---	--- ---
Ft. Gordon STP Effluent	FG-8 AM FG-8 PM	>1,600,000 >1,600,000	1,100,000 700,000	--- 2,300,000	2,300,000 ---	--- ---
Spirit Creek	SC-9	46,000	23,000	1,400	23,000	11,000
Spirit Creek	SC-10	90	4,900	490	330	1,700
Spirit Creek	SC-11	1,700	330	---	2,200	330
Reeds Creek	RC-12	50	---	---	---	140
Lake Olmstead	LO-13	110	---	---	---	130
Gwinnet St. Drainage Ditch	G-14	>1,600,000	---	---	---	17,000,000
Camille Street Ditch	U-15	35,000,000	---	---	---	22,000,000
Oates Creek	OC-16	110,000	---	---	---	4,900
Rocky Creek	RO-17	17,000	---	---	---	1,200,000
Columbia Nitrogen - Caprolactum Plant	CN-18	---	---	<20	7,900	---
Columbia Nitrogen - Nitrogen Plant		---	---	4,600	4,900	---
Butler Creek Sewage Treatment Plant	BC-19	---	---	<2,000	1,100	1,100

TABLE B-II cont'd

Location	Station Number	Fecal Coliform Bacteria/100 ml		
		7/28/70	7/29/70	7/30/70
Savannah River	S-47A	1,700	2,300	1,700
" "	S-47E	1,700	1,400	3,300
" "	S-66A	490	1,700	2,200
" "	S-66E	1,700	700	1,100
" "	S-67A	3,300	2,300	4,600
" "	S-67E	7,000	2,300	7,000
" "	S-68A	3,300	3,300	2,800
" "	S-68E	1,300	2,300	1,700
" "	S-69A	3,300	3,300	3,300
" "	S-69E	2,300	790	3,300
" "	S-70A	1,300	3,300	1,100
" "	S-70E	3,300	1,300	1,300
" "	S-71A	1,700	2,300	1,300
" "	S-71E	4,900	2,800	13,000

TABLE B-II cont'd

Location	Station Number	Fecal Coliform Bacteria/100 ml				
		7/13/70	7/14/70	7/15/70	7/16/70	7/17/70
Continental Can Paper Mill	CC-20	---	---	3,300	33,000	---
Continental Can Sludge Lagoon		---	---	49,000	49,000	---
Kelly Creek	KC-21	170	330	110	230	170
Kelly Creek	KC-22	3,300	7,900	4,900	3,100	2,300
Kelly Creek	KC-23	4,900	4,900	3,300	3,300	1,300
Kelly Creek	KC-24	79,000	>160,000	33,000	140,000	2,300,000
Horse Creek	HC-25	110	790	330	170	110
Graniteville Textile Mill	GM-26	<200	<20	<20	<20	<20
Horse Creek	HC-27	<200	<20	20	<20	<20
Valchem Plant	V-28	110	3,300	490	490	3,300
Horse Creek	HC-29	200	130	80	<20	790
Horse Creek	HC-30	23,000	54,000	23,000	33,000	11,000
Little Horse Creek	LHC-31	<200	13,000	330	490	230
Clearwater Finishing Plant	CM-32	<20	<20	<20	<20	<20
Little Horse Creek	LHC-33	79,000	13,000	49,000	13,000	700
Horse Creek	HC-34	33,000	23,000	33,000	7,900	22,000
Horse Creek	HC-35	17,000	17,000	4,900	3,300	4,600
Aiken, S.C. STP	A-36	7,900,000	7,000,000	---	---	---
Warrenville, S.C. STP	W-37	490,000	16,000,000	490,000 (7/12/70)	---	---
Bath Mill	B-38	---	---	3,300	14,000	<20
Seminole Mill	SM-39	---	---	700	490	110
Kimberly Clark Company	KC-40	---	---	80	170	270
Langley Pond	LP-42	< 200	20	---	---	---

TABLE B-II cont'd

Location	Station Number	Fecal Coliform Bacteria/100 ml					
		7/23/70			7/24/70		
		1000-1300	1400-1700	1800-2100	2200-0100	0200-0500	0600-0900
North Augusta Untreated Sewage	NA-41	13,000,000	54,000,000	24,000,000	24,000,000	11,000,000	17,000,000

TABLE B-II cont'd

Location	Station Number	Fecal Coliform Bacteria/100 ml		
		7/20/70	7/21/70	7/22/70
Lower Three Runs Creek	LTR-43	110	20	130
J.P. Stevens Company	JPS-44	2,400,000	17,000,000	7,900,000
Lower Three Runs Creek	LTR-45	1,700	13,000	2,300
Lower Three Runs Creek	LTR-46	200	80	790

TABLE B-II cont'd

Location	Station Number	Fecal Coliform Bacter/100 ml			
		8/1/70	8/2/70	8/3/70	8/4/70
Savannah River	S-53A	4,600	2,300	13,000	23,000
" "	S-53E	54,000	33,000	17,000	23,000
" "	S-58A	160,000	11,000	4,600	7,900
" "	S-58E	24,000	9,400	3,300	23,000
" "	S-73A	50	20	170	20
" "	S-73E	<20	70	130	20
" "	S-74A	490	92,000	>160,000	3,300
" "	S-74C	700	7,900	460	4,900
" "	S-74E	35,000	23,000	7,000	130,000
" "	S-77A	33,000	2,100	4,900	13,000
" "	S-77C	92,000	4,900	7,900	22,000
" "	S-77E	54,000	7,000	23,000	130,000
" "	S-83A	130,000	33,000	4,900	7,900
" "	S-83C	130,000	49,000	33,000	70,000
" "	S-83E	110,000	240,000	70,000	350,000
" "	S-86A	240,000	79,000	49,000	79,000
" "	S-86E	130,000	33,000	13,000	70,000
" "	S-88A	79,000	130,000	79,000	49,000
" "	S-88C	94,000	79,000	70,000	33,000
" "	S-88E	350,000	130,000	28,000	49,000

TABLE B-III

SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

Location	Station	Fecal Coliform Bacteria/100 ml Maximum	Minimum	Arithmetic Mean	Geometric Mean	Number of Samples
Industrial Canal	IC-1	130	20	48	35	5
Industrial Canal	IC-2	50	20	26	24	5
Industrial Canal	SI-3	330	20	120	69	5
Industrial Canal	HG-4	46,000	7,900	23,000	20,000	5
Butler Creek	BC-5	1,300	230	600	480	5
Butler Creek	BC-6	17,000,000	3,300,000	7,300,000	5,900,000	5
Fort Gordon STP Influent	FG-7	110,000,000	33,000,000	79,000,000	73,000,000	6
Fort Gordon STP Effluent	FG-8	2,300,000	700,000	1,600,000	1,500,000	6
Spirit Creek	SC-9	46,000	1,400	21,000	13,000	5
Spirit Creek	SC-10	4,900	90	1,500	660	5
Spirit Creek	SC-11	2,200	330	1,100	800	4
Reed Creek	RC-12	140	50	95	84	2
Lake Olmstead	LO-13	130	110	120	120	2

TABLE B-III

SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

Location	Station	Fecal Coliform Bacteria/100 ml Maximum	Minimum	Arithmetic Mean	Geometric Mean	Number of Samples
Gwinnett St. Drainage	G-14	17,000,000	>1,600,000			2
Camille St. Ditch	U-15	35,000,000	22,000,000	29,000,000	28,000,000	2
Oates Creek	OC-16	110,000	4,900	57,000	23,000	2
Rocky Creek	RO-17	1,200,000	200	410,000	16,000	3
Columbia Nitrogen Plant		4,900	4,600	4,800	4,800	2
Columbia Nitrogen Caprolactum Plant	CN-18	7,900	<20	4,000	400	2
Butler Creek STP Effluent	BC-19	<2,000	11,000	14,000	1,300	3
Continental Can	CC-20	33,000	3,300	18,000	10,000	2
Continental Can Sludge Lagoon Effluent		49,000	49,000	49,000	49,000	2
Kelly Creek	KC-21	330	110	200	190	5

TABLE B-III

SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

Location	Station	Fecal Coliform Bacteria/100 ml				Number of Samples
		Maximum	Minimum	Arithmetic Mean	Geometric Mean	
Kelly Creek	KC-22	7,900	2,300	4,300	3,900	5
Kelly Creek	KC-23	4,900	1,300	3,500	3,200	5
Kelly Creek	KC-24	2,300,000	33,000	540,000	170,000	5
Horse Creek	HC-25	790	110	300	220	5
Horse Creek	HC-27	< 200	<20	<20	<20	5
Horse Creek	HC-29	790	<20	240	130	5
Horse Creek	HC-30	54,000	11,000	29,000	25,000	5
Horse Creek	HC-34	33,000	7,900	24,000	21,000	5
Horse Creek	HC-35	17,000	3,300	9,400	7,400	5
Langley Pond	LP-42	<200	20			2
Little Horse Creek	LHC-31	13,000	<200	2,900	630	5
Little Horse Creek	LHC-33	79,000	700	31,000	14,000	5
Graniteville Mill	GM-26	<200	<20	<20	<20	5

TABLE B-III

SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

Location	Station	Fecal Coliform Bacteria/100 ml Maximum	Minimum	Arithmetic Mean	Geometric Mean	Number of Samples
Valchem Mill	V-28	3,300	110	1,500	780	5
Clearwater Finishing Plant	CM-32	<20	<20	<20	<20	5
Aiken, S.C. STP Effluent	A-36	7,900,000	7,000,000	7,500,000	7,400,000	2
Warrenville, S.C. STP Effluent	W-37	>16,000,000	490,000	8,200,000	2,800,000	3
Bath Mill	B-38	14,000	<20	5,800	970	3
Seminole Mill	SM-39	700	110	430	340	3
Kimberly Clark	KC-40	270	80	170	150	3
North Augusta, S.C. Sewage	NA-41	54,000,000	11,000,000	24,000,000	21,000,000	6
Lower Three Runs Creek	LTR-43	130	20	87	66	3
Lower Three Runs Creek	LTR-45	13,000	1,700	5,700	3,700	3
Lower Three Runs Creek	LTR-46	790	80	360	230	3

TABLE B-III

SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

		Fecal Coliform Bacteria/100 ml				
Location	Station	Maximum	Minimum	Arithmetic Mean	Geometric Mean	Number of Samples
J.P. Stevens Plant	JPS-44	17,000,000	2,400,000	9,100,000	6,900,000	3
Savannah River	S-50-A	130	20	48	35	5
Savannah River	S-73A	170	20	65	43	4
Savannah River	S-73E	130	< 20	60	44	4
Savannah River	S-74A	> 160,000	490	64,000	12,000	4
Savannah River	S-74C	7,900	460	3,500	1,900	4
Savannah River	S-74E	130,000	7,000	49,000	29,000	4
Savannah River	S-53A	23,000	2,300	11,000	7,500	4
Savannah River	S-53E	54,000	17,000	32,000	29,000	4
Savannah River	S-77A	33,000	2,100	13,000	8,000	4
Savannah River	S-77C	92,000	4,900	32,000	17,000	4
Savannah River	S-77E	130,000	7,000	54,000	33,000	4
Savannah River	S-58A	160,000	46,000	46,000	16,000	4
Savannah River	S-58E	24,000	3,300	15,000	11,000	4

TABLE B-III

SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

Location	Station	Fecal Coliform Bacteria/100 ml				Number of Samples
		Maximum	Minimum	Arithmetic Mean	Geometric Mean	
Savannah River	S-83A	130,000	4,900	44,000	20,000	4
Savannah River	S-83C	130,000	33,000	71,000	62,000	4
Savannah River	S-83E	350,000	70,000	190,000	160,000	4
Savannah River	S-86A	240,000	49,000	110,000	93,000	4
Savannah River	S-86E	130,000	13,000	62,000	44,000	4
Savannah River	S-88A	130,000	49,000	84,000	79,000	4
Savannah River	S-88C	94,000	33,000	69,000	64,000	4
Savannah River	S-88E	350,000	28,000	140,000	89,000	4
Savannah River	S-47A	2,300	1,700	1,900	1,900	3
Savannah River	S-47E	3,300	1,400	2,100	2,000	3
Savannah River	S-66A	2,200	490	1,500	1,200	3
Savannah River	S-66E	1,700	700	1,200	1,100	3
Savannah River	S-67A	4,600	2,300	3,400	3,300	3
Savannah River	S-67E	7,000	2,300	5,400	4,800	3

TABLE B-III

SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

		Fecal Coliform Bacteria/100 ml				
Location	Station	Maximum	Minimum	Arithmetic Mean	Geometric Mean	Number of Samples
Savannah River	S-68A	3,300	2,800	3,100	3,100	3
Savannah River	S-68E	2,300	1,300	1,800	1,700	3
Savannah River	S-69A	3,300	3,300	3,300	3,300	3
Savannah River	S-69E	3,300	790	2,100	1,800	3
Savannah River	S-70A	3,300	1,100	1,900	1,700	3
Savannah River	S-70E	3,300	1,300	2,000	1,800	3
Savannah River	S-71A	2,300	1,300	1,800	1,700	3
Savannah River	S-71E	13,000	2,800	6,900	5,600	3

TABLE B-IV

THE TEN MOST FREQUENTLY REPORTED SALMONELLA SEROTYPES DURING JULY 1970 [1]

Human Sources		Nonhuman Sources	
Rank	Serotypes	Rank	Serotypes
1	Salmonella typhi-murium*	1	Salmonella typi-murium*
2	S. enteritidis	2	S. heidelberg
3	S. newport	3	S. anatum
4	S. heidelberg	4	S. schwarzengrund
5	S. infantis	5	S. infantis
6	S. saint-paul	6	S. saint-paul
7	S. thompson	7	S. montevideo
8	S. blockley	8	S. worthington
9	S. derby	9	S. san-diego
10	S. montevideo	10	S. indiana

*Includes variety copenhagen

[1] According to Report No. 100, Center for Disease Control Salmonella Surveillance for July, 1970.

TABLE B-V

LIST OF SAMPLING SITES FOR SALMONELLA AND THE SEROTYPES RECOVERED

Stream	Station	Salmonella Serotypes Isolated
Industrial Canal	IC-2	S. muenchen, S. mississippi, S. give
Industrial Canal	HG-4	S. st. paul, S. havana, S. senftenberg
Butler Creek	BC-5	S. sieburg
Butler Creek	BC-6	S. simsbury, S. anatum, S. cubana, S. thompson
Spirit Creek	FG-8	S. cubana, S. binza, S. minnesota
Spirit Creek	SC-10	S. rubislaw, S. muenchen, S. mississippi
Spirit Creek	SC-11	S. madelia
Horse Creek	HC-27	None detected
Horse Creek	HC-30	S. montivideo
Horse Creek	HC-35	None detected
Little Horse Creek	LHC-31	S. rubislaw
Little Horse Creek	LHC-33	None detected
Kelly Creek	A-36	S. muenchen
Kelly Creek	W-37	S. heidelberg, S. typhimurium var. copenhagen
Lower Three Runs Creek	JPS-44	None detected
Lower Three Runs Creek	LTR-46	None detected
Savannah River	S-50	None detected
Savannah River	S-73A	S. newport, S. panama
Savannah River	S-51E	S. javiana, S. muenchen, S. panama, S. montivedeo, S. oranienburg
Savannah River	NA-41	S. panama
Savannah River	S52-L	S. muenchen, S. typhimurium, S. mississippi, S. newport

TABLE B-V cont'd

LIST OF SAMPLING SITES FOR SALMONELLA AND THE SEROTYPES RECOVERED

Stream	Station	Salmonella Serotypes Isolated
Savannah River	S-78-A	S. panama
Savannah River	S-78-B	S. muenchen, S. heidelberg
Savannah River	S-82	S. typhimurium
Savannah River	S-87	S. muenster, S. newport, S. cubana, S. typhimurium var. copenhagen
Savannah River	S-91	S. typhimurium, S. muenchen, S. newport, S. muenster, S. derby, S. heidelberg
Savannah River	S-47A	S. muenchen, S. typhimurium, S. typhimurium var. copenhagen
Savannah River	S-48	S. typhimurium var. copenhagen
Savannah River	S-70A	S. typhimurium, S. halmstad, E_1 eh, z_{48}

TABLE B-VI

COMPARISONS OF MEAN FECAL COLIFORM BACTERIA LEVELS AT SELECTED SITES THAT ALSO HAD SALMONELLA PRESENT

Stream	Station	Fecal Coliform Bacteria/100ml[1]	Geometric Mean Fecal Coliform Bacteria/100 ml	Number of Salmonella Serotypes Isolated
Industrial Canal	IC-2	20	24	3
Industrial Canal	HG-4	7,900	20,000	3
Butler Creek	BC-5	230	480	1
Butler Creek	BC-6	3,300,000	5,900,000	4
Spirit Creek	FG-8	2,300,000	1,500,000	3
Spirit Creek	SC-10	1,700	660	3
Spirit Creek	SC-11	330	800	1
Horse Creek	HC-27	<20	<20	0
Horse Creek	HC-30	11,000	25,000	1
Horse Creek	HC-35	4,600	7,400	0
Little Horse Creek	LHC-31	230	630	1
Little Horse Creek	LHC-33	700	14,000	0
Kelly Creek	A-36	7,000,000	7,400,000	3
Kelly Creek	W-37	>16,000,000	2,800,000	2
Savannah River	S-50	20	35	0
Savannah River	S-73A	20	43	2
Savannah River	S-51E	130,000[2]	29,000[2]	5
Savannah River	NA-41	17,000,000	21,000,000	1
Savannah River	S-52-L	—	--	4
Savannah River	S-78-A	13,000[3]	8,000[3]	1
Savannah River	S-78-B	22,000[3]	17,000[3]	2
Savannah River	S-82	350,000[4]	160,000[4]	1

TABLE B-VI

COMPARISONS OF MEAN FECAL COLIFORM BACTERIA LEVELS AT SELECTED SITES THAT ALSO HAD *SALMONELLA* PRESENT

Stream	Station	Fecal Coliform Bacteria/100 ml 1/	Geometric Mean Fecal Coliform Bacteria/100 ml	Number of Salmonella Serotypes Isolated
Savannah River	S-87	49,000 5/	89,000 5/	4
Savannah River	S-91	--	--	6
Savannah River	S-47-A	1,700	1,900	3
Savannah River	S-48	--	--	1
Savannan River	S-70-A	1,100	1,700	3
Lower Three Runs Creek	JPS-44	7,900,000	6,900,000	0
Lower Three Runs Creek	LTR-46	790	230	0

1/ Fecal coliform bacteria density at station on day of *Salmonella* swab collection.

2/ No fecal coliform bacteria determinations were made at Station S-51E. The fecal coliform bacteria density as measured at Station S-74E, located approximately 300 yards downstream from Station S-51E, was used in the table for comparative purposes.

3/ No fecal coliform bacteria determinations were made at Station S-78-A and S-78-B. The fecal coliform bacteria density, as measured at Stations S-77-A and S-77-B, located approximately 200 yards upstream from Stations S-78-A and S-78-B, were used in the table for comparative purposes.

4/ No fecal coliform bacteria determinations were made at Station S-82. The fecal coliform bacteria density as measured at Station S-83-E, located approximately 200 yards downstream from Station S-82, was used in the table for comparative purposes.

5/ No fecal coliform bacteria determinations were made at Station S-87. The fecal coliform bacteria density as measured at Station S-88-E, located approximately 200 yards downstream from Station S-87, was used in the table for comparative purposes.

TABLE B-VII

IDENTIFICATION SCHEME FOR SALMONELLA SUSPECTS

Suspect colony (picked from differential plate)

Triple Sugar Iron Agar (TSI)

Alkaline slant and acid butt with or without H_2S

Acid slant and butt; Alkaline slant and butt - DISCARDED

Urease Production

Positive
DISCARDED

Negative

Cytochrome Oxidase

Positive
DISCARDED

Negative

Polyvalent 'O' Antisera

Positive

Negative
DISCARDED

Lactose; Sodium Malonate; Potassium Cyanide

Positive
DISCARDED

Negative

Lysine decarboxylase; Citrate

Negative
DISCARD

Positive

Serological Identification

Verification by NCDC

APPENDIX C -i.

BIOLOGICAL STUDIES
MIDDLE REACH SAVANNAH RIVER

by

Lee Tebo

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MIDDLE REACH SAVANNAH RIVER
BIOLOGICAL STUDIES

Summary and Conclusions:

Biological studies consisted of sampling of the vascular plants, plankton, periphyton and macroinvertebrates at stations above and below waste sources on the Savannah River and major tributaries in a 75 mile reach of river between North Augusta, South Carolina and Allendale, South Carolina. Concurrent with the biological studies data were collected on the diurnal cycle of oxygen in the Savannah River and on the levels of carbon and chromium in the sediments. Tributaries studied included Horse Creek, Butler Creek, Spirit Creek and Lower Three Runs Creek.

The results of these studies may be summarized as follows:

(1) Kelly Creek, a tributary of Horse Creek, is degraded by domestic wastes originating from Aiken, South Carolina and Graniteville, South Carolina and sludge deposits were present in this creek below the outfalls of the sewage treatment plants from the above towns.

(2) Little Horse Creek, a tributary of Horse Creek, is "grossly polluted" by domestic and industrial wastes originating in the vicinity of Clearwater, South Carolina. Sludge deposits in this creek contained 163 ppm of chromium.

(3) Horse Creek for a distance of at least 1.6 miles from its mouth was a "dead" stream and contained no living macroinvertebrate organisms. Sludge deposits in this creek contained 990 ppm of chromium, a concentration many fold higher than that reported to be toxic to aquatic life, including fish.

(4) Butler Creek, in its upper reaches, is affected by low levels of organic wastes and below the ditches draining the southern part of Augusta, Georgia it is polluted by organic wastes sufficient to deplete the oxygen. In the lower section, just above its junction with the Savannah River, the bottom of Butler Creek is covered with active sludge deposits supporting a dense population of sludge worms.

(5) Spirit Creek, just above Continental Can, was subject to low levels of organic wastes from Fort Gordon and below Continental Can was "grossly polluted" by organic wastes in quantities sufficient to deplete the oxygen. Black liquor from Continental Can severely reduced the transparency of this Creek.

(6) Lower Three Runs Creek was "grossly polluted" by organic wastes from J. P. Stevens and sludge deposits in the lower reach of this creek contained an average of 10.7 per cent carbon.

(7) During July, 1970 the measured flow from all known waste sources in the 75 mile reach of the Savannah River studied was approximately 110 cubic feet per second (cfs). Average flow of the Savannah River during July at Savannah Bluff Lock and Dam was approximately 6120 cfs providing a 60:1 dilution for wastes entering the river over the 75 mile reach. Because of the high rate of waste dilution after mixing, the effects of individual waste sources on the river are subtle and difficultly measurable.

For a distance of at least 1000 yards below the mouth of Horse Creek the east central portion of the river bottom was coated with slimy fibrous sludge deposits, samples of which contained 5.8 per cent carbon. These sludge deposits contained measured chromium concentrations of 670 ppm which appeared to be having a teratogenic effect on the midge larva Chironomus attenuatus; the only living macroinvertebrate inhabitant of the deposits. Some chromium was contributed from the industrial canal with concentrations as high as 32 ppm found in sediments immediately above Horse Creek.

Dissolved oxygen below 5.0 ppm was not detected during the period of this study, however a diurnal study of dissolved oxygen showed that wastes originating in the reach of river between Hawk's Gully and Horse Creek were of sufficient magnitude to significantly reduce the oxygen assets in this "upper section" of the river.

The cumulative effects of enrichment from organic wastes discharged to the river was reflected in the standing crops of plankton and periphyton which increased in total quantity and contained increasing amounts of filamentous green and bluegreen algae at downstream stations. The increased standing crops and decrease in diversity of macroinvertebrates inhabiting artificial substrate samplers were further evidence of an enriched, semi-healthy environment. The minimum diversity was found at stations immediately below Spirit Creek which were subject to the cumulative effects of upstream wastes originating in the states of Georgia and South Carolina. As measured by the diversity of the macroinvertebrate community the river never fully recovers before reaching Lower Three Runs Creek, the lowermost source of pollution. Below Lower

Three Runs Creek the macroinvertebrate population is again reduced to a level indicative of a semi-healthy environment.

On the basis of the biological data collected during this study the entire reach of the Savannah River from Augusta, Georgia downstream to Johnson's Landing would be classified as semi-healthy. Additional stress from further inputs of oxygen demanding wastes or toxic materials could have potentially catastrophic effects on the river and its biota.

MIDDLE REACH SAVANNAH RIVER

BIOLOGICAL STUDIES

Introduction:

Since 1951 the Philadelphia Academy of Science, under contract to the Atomic Energy Division of E. I. duPont Nemours and Company, has been conducting biological studies of the Savannah River.

In a summary analysis of 20 years of detailed study (4) of all components of the aquatic flora and fauna the Philadelphia Academy found that since 1951-1952, at four stations in the reach of river between Savannah Bluff Lock and Dam and Highway 301 bridge, there has been an increase in the mineralized nutrient load with a concomitant decrease in diversity of organisms and a change in the more common species. This same report cited evidence of toxic pollution occurring in several instances between 1965 and 1968. The report also mentions evidence of pollution to Lower Three Runs which has affected the Savannah River downstream to Allendale bridge.

The Institute of Paper Chemistry, under contract to the Continental Can Company has since 1959 conducted studies of the Savannah River from just above the Savannah Bluff Lock and Dam (river mile 188) downstream to river mile 149. The Institue of Paper Chemistry studies were based primarily on an evaluation of bottom dwelling macroinvertebrates by comparing the presence of tolerant and intolerant genera. A summary of these data for the period 1959-1965(2) classified all but one Savannah River station as balanced. Stations at the mouth of Butler Creek were classified as polluted.

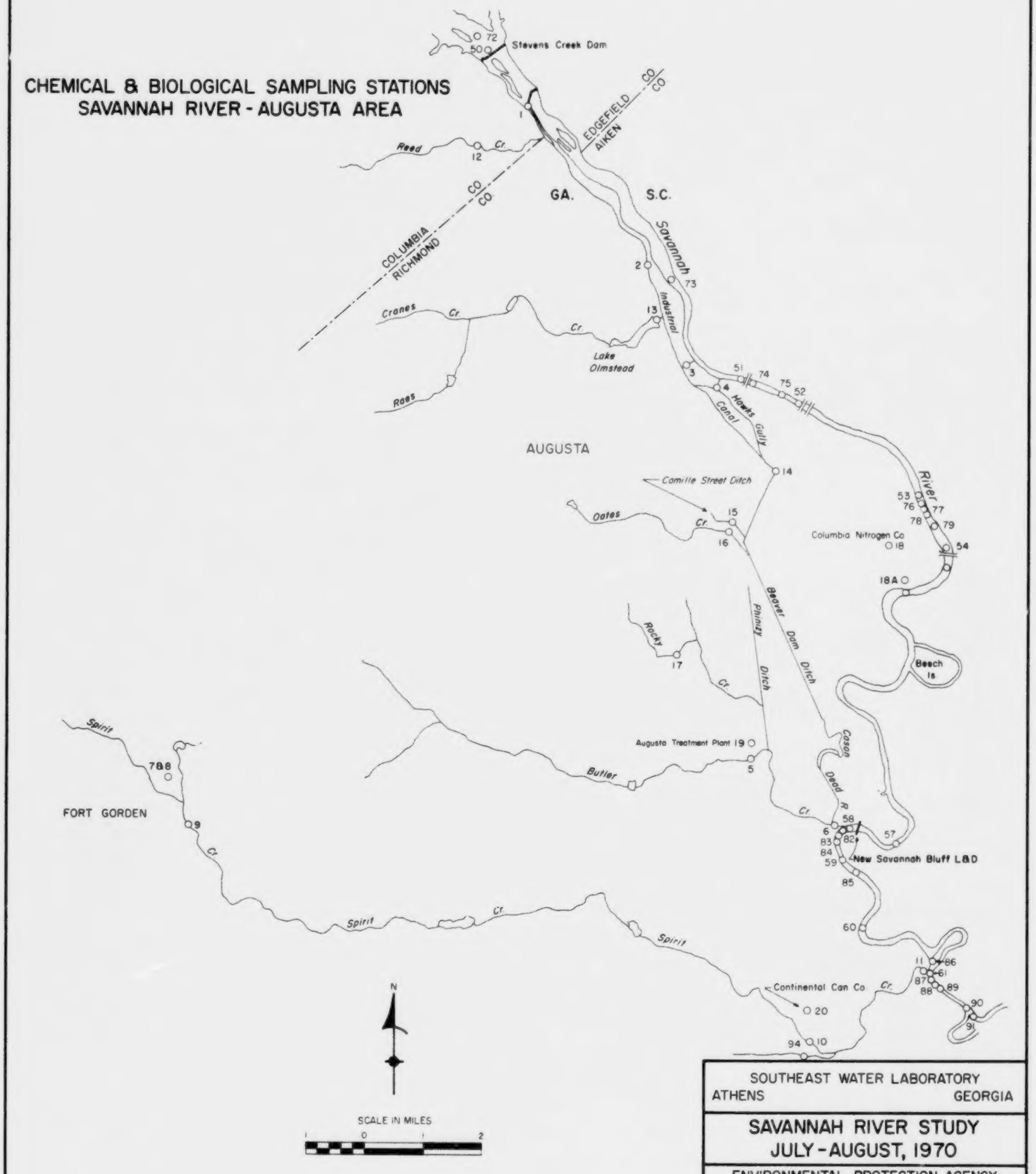
During the early spring of 1967 the southeast region of the Federal Water Quality Administration conducted cursory studies of the macroinvertebrates at stations on Little Horse Creek, Horse Creek, Kelly Creek, Butler Creek, Spirit Creek and the Savannah River from Augusta, Georgia downstream to Silver Bluff Landing (river mile 174). This study(5) classified the lower reaches of Horse Creek, Little Horse Creek, Butler Creek and Spirit Creek as "grossly polluted". Inadequate data were available to categorize the condition of stations in the Savannah River proper.

During the late summer and early fall of 1970 the Federal Water Quality Administration conducted studies of the fauna and flora at stations on streams tributary to the Savannah River including Little Horse Creek, Kelly Creek, Horse Creek, Spirit Creek, Butler Creek and Lower Three Runs Creek and at stations in the Savannah River from the North Augusta, South Carolina water intake downstream to Johnson's Landing which is near river mile 125 and six miles upstream from Highway 301 bridge. These studies were designed to determine the effects of waste sources entering the tributaries on the biota of the tributaries plus the individual and cumulative effects of all waste sources on the biological characteristics of the Savannah River proper.

Sampling stations are shown on Figures 1, 2 and 3 and described in Appendix III.

C-6a

FIGURE C-1



72
50
Stevens Creek Dam
1
Reed
Cr.
12
EDGEFIELD CO
AIKEN CO
COLUMBIA CO
RICHMOND CO
GA.
S.C.
Savannah
2
73
Industrial
13
Cranes
Cr.
Cr.
Lake Olmstead
Raes
3
4
Canal
Hawks Gully
51
74
75
52
River
AUGUSTA
14
Camille Street Ditch
Oates
Cr.
15
16
53
76
77
78
79
Columbia Nitrogen Co
18
54
18A
Beaver Dam Ditch
Phinizy Ditch
Rocky
17
Cr.
Beech Is
Spirit
7&8
FORT GORDEN
9
Cr.
Augusta Treatment Plant 19
5
Butler
Cason
Dead R
Cr.
58
6
82
83
84
59
57
New Savannah Bluff L&D
85
Spirit
Cr.
Spirit
60
11
86
61
87
88
89
90
91
Continental Can Co
Cr.
20
94
10
N
SCALE IN MILES
1
0
1
2

CHEMICAL & BIOLOGICAL SAMPLING STATIONS
SAVANNAH RIVER - AUGUSTA AREA

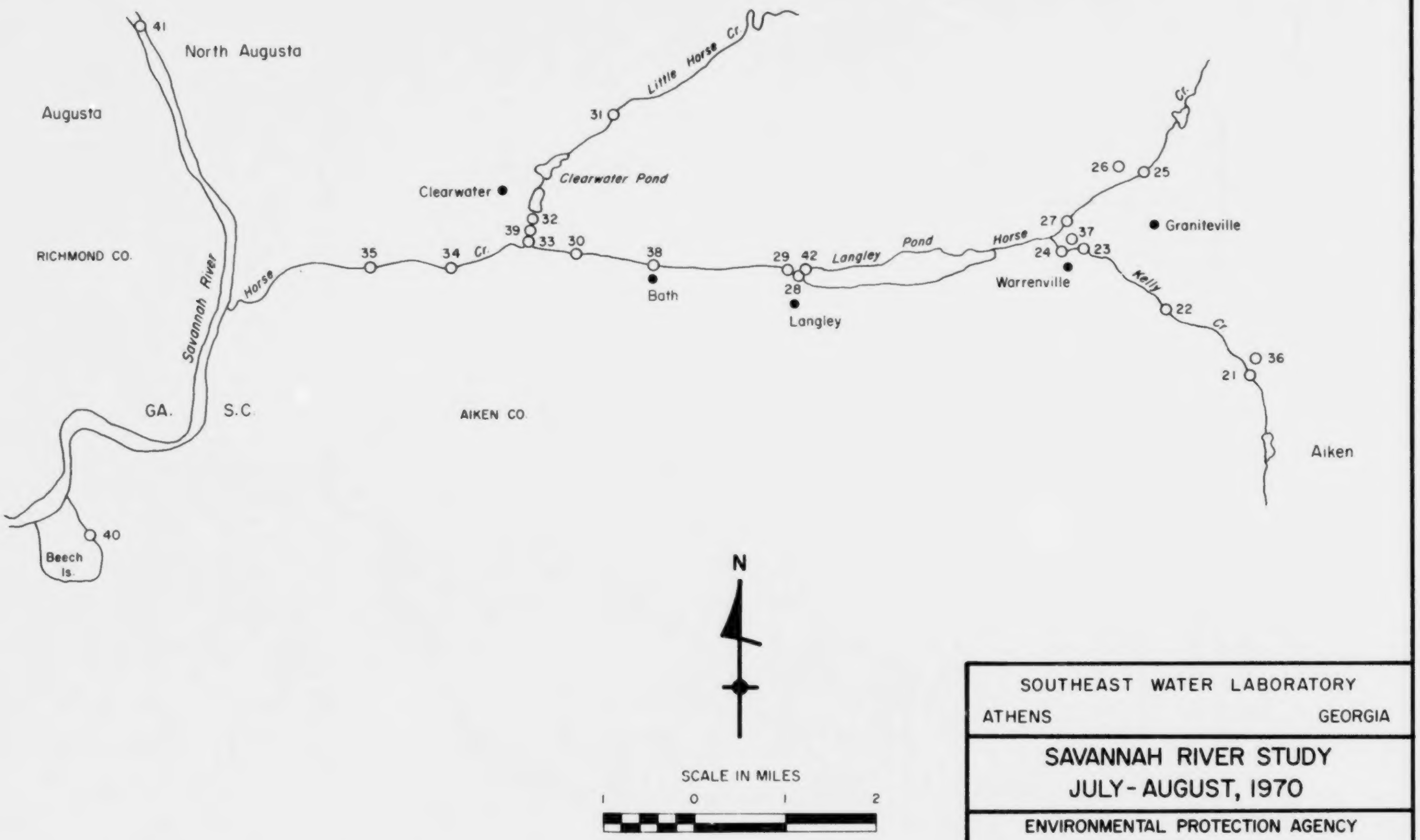
SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY - AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

FIGURE C-2

CHEMICAL & BIOLOGICAL SAMPLING STATIONS
SAVANNAH RIVER - HORSE CREEK AREA


41
North Augusta
Augusta
RICHMOND CO.
Savannah River
Horse
GA.
S.C.
40
Beech Is.
35
34
Cr.
Clearwater
Clearwater Pond
31
Little Horse Cr.
32
39
33
30
38
Bath
AIKEN CO.
29
42
28
Langley
Langley Pond
Horse
27
26
25
Cr.
Graniteville
37
24
23
Warrenville
Kelly
22
Cr.
36
21
Aiken
N
SCALE IN MILES
1
0
1
2

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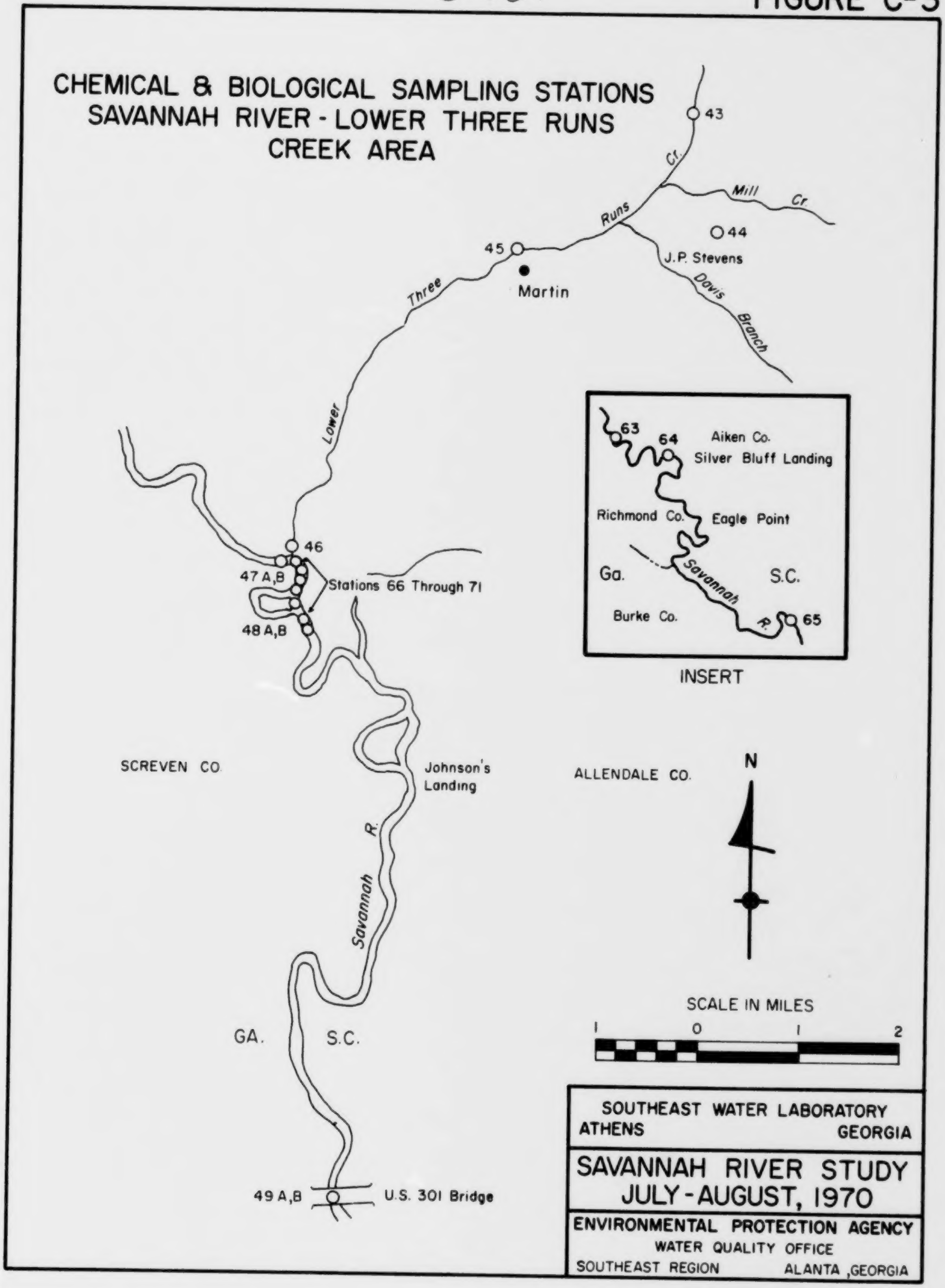
C-6C.

FIGURE C-3



CHEMICAL & BIOLOGICAL SAMPLING STATIONS
SAVANNAH RIVER - LOWER THREE RUNS
CREEK AREA

43
Cr.
Mill Cr.
Runs
44
45
J.P. Stevens
Davis Branch
Three
Martin
Lower
46
47 A,B
Stations 66 Through 71
48 A,B
63
64
Aiken Co.
Silver Bluff Landing
Richmond Co.
Eagle Point
Ga.
Savannah R.
S.C.
Burke Co.
65
INSERT
SCREVEN CO.
Johnson's Landing
ALLENDALE CO.
N
Savannah R.
SCALE IN MILES
1
0
1
2
GA.
S.C.
49 A,B
U.S. 301 Bridge

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY - AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
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SOUTHEAST REGION ALANTA, GEORGIA

Studies included an evaluation of plankton, periphyton and macroinvertebrate communities at river and tributary stations utilizing methods described in Appendix I . Based on characteristics of the flora and fauna various reaches of the Savannah River and tributaries were categorized as follows:

Healthy - Supports a diverse but often sparse community of attached algae and macroinvertebrates including genera and species known to be intolerant of even moderate levels of organic pollution. "Equitability" (8) of distribution of individuals among the species from quantitative samples of the community of macroinvertebrates is greater than 0.6 and often approaches 1.0. The environment would be considered clean with no organic or toxic pollutants present.

Semi-healthy - Supports a diverse and abundant community of attached algae, bacteria, fungi and macroinvertebrates but forms known to be sensitive to even low levels of organic pollution are scarce or absent. Standing crop of macroinvertebrates is usually high and some forms may dominate the population with a concomitant reduction in equitability which usually ranges between 0.3 and 0.6. This type of community of lotic organisms serves as a warning that the environment is borderline and subject to external stress. Added increments of organic materials can very quickly result in polluted conditions.

Polluted - Supports a community with a large standing crop of a few species of algae, fungi, bacteria and macroinvertebrates. Community of aufwuchs (attachment materials) is often dominated by sewage fungus with a community of macroinvertebrates comprised of forms insensitive to or independent of frequent depressions of the dissolved oxygen. Equitability is severely reduced ranging from 0.1 to 0.3. This environment is subject to high levels of organic pollutants and/or chronic (sublethal) levels of toxicants.

Grossly Polluted - This is an environment subject to high and continuing levels of organic pollution such that septic conditions are created and/or an environment subject to acutely toxic pollutants.

In the case of continuously septic conditions created by excess organic wastes the "aufwuchs" may be comprised almost wholly of "sewage fungus" and the macroinvertebrate community of only one or two species of macroinvertebrates which may be present in tremendous numbers. In the case of toxic materials there may be no forms of macroinvertebrates present, or in rare cases a species may be present that is tolerant of the particular type of toxicant being discharged.

The above arbitrary classifications apply primarily to lotic (flowing) waters and may be modified by physical characteristics of the habitat such as substrate, velocity and depth. Interpretations of qualitative data must be based on careful and intensive sampling of all available habitats and the validity of interpretation is enhanced if data from similar unpolluted control stations are available.

Data from artificial substrates reduce the effect of confounding factors such as substrate and depth and provide an objective appraisal of the macroinvertebrates. Artificial substrate data must however be supplemented by information on the characteristics of the natural substrate in the stream and the effect of waste materials thereon.

Tributary Survey:

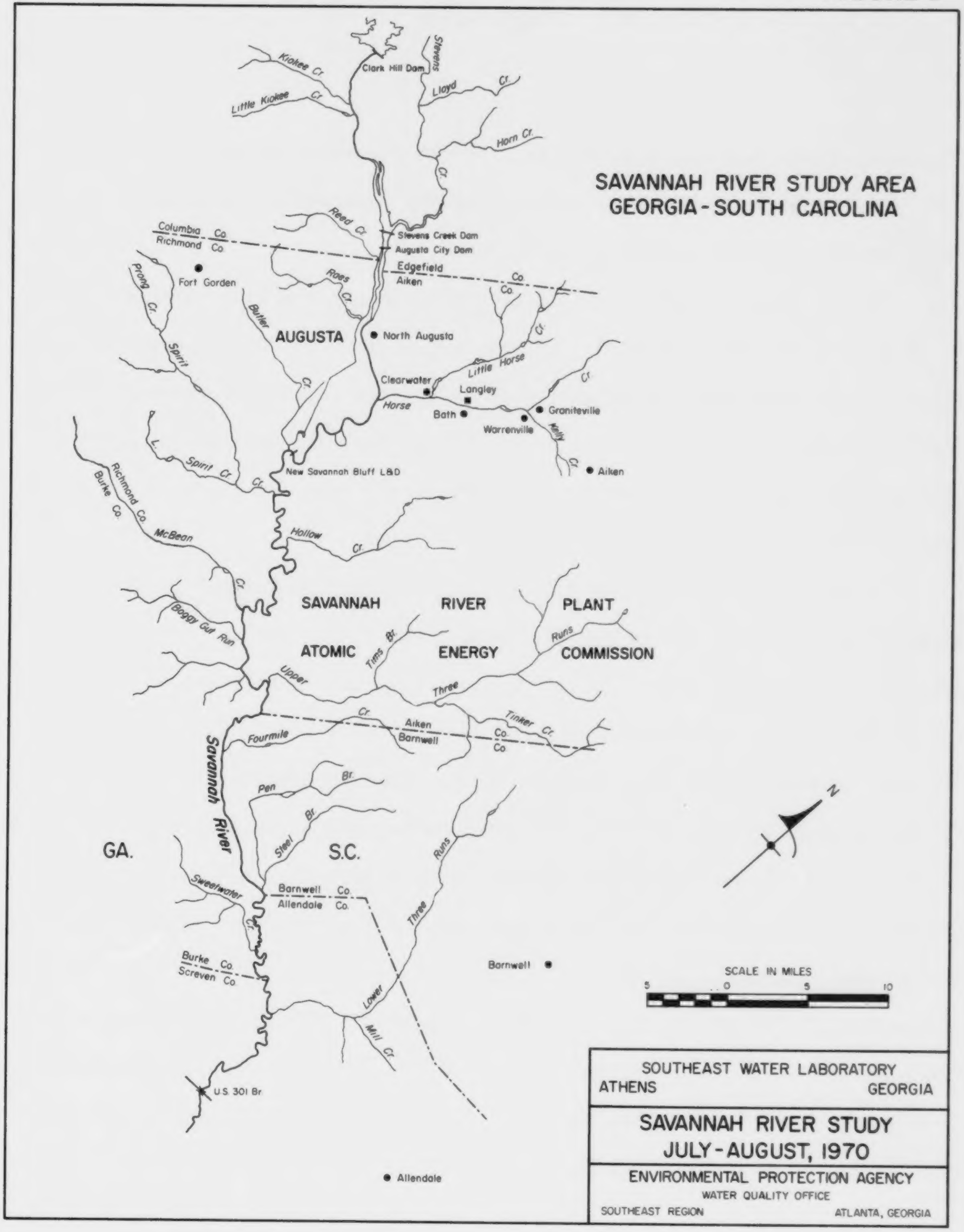
In the reach of Savannah River studied there were four major tributaries known to be subject to significant amounts of industrial and municipal pollution. In downstream order these tributaries included Horse Creek, Butler Creek, Spirit Creek and Lower Three Runs Creek (Fig. 4). The physical characteristics and biota of all tributary stations are presented in Appendix III.

Horse Creek drains an area of South Carolina immediately south of North Augusta, South Carolina and empties into the Savannah River at mile 197.4. In addition to municipalities and industries discharging directly into Horse Creek there were two tributaries--Kelly Creek and Little Horse Creek--that received significant quantities of wastes which ultimately reached Horse Creek (Fig. 2 and section on waste sources).

Kelly Creek originates near Aiken, South Carolina and flows in a northwesterly direction to its junction with Horse Creek near Graniteville, South Carolina. Kelly Creek, in the area studied, was a shallow (1-2 feet maximum depth) swiftly flowing, sandy-bottomed stream ranging from 15 feet in width at the upper station (KC-21) to 25 feet in width at the downstream station (KC-24). Sludge deposits were appareent at stations KC-22 and KC-24 and sediment samples revealed a carbon content of 4.1 and 3.0 per cent respectively at these two stations (Table 1). Sediments from control station KC-21 contained only 0.2 per cent carbon. The fauna collected at all stations show that, even at the upper control station, Kelly Creek is subject to moderate levels of organic pollution (Appendix II). Station KC-21 was established as a control and was

C-9a

FIGURE C–4


Clark Hill Dam
Stevens
Kiokee Cr.
Little Kiokee Cr.
Lloyd Cr.
Horn Cr.
Cr.
Reed Cr.
Stevens Creek Dam
Augusta City Dam
Columbia Co.
Richmond Co.
Edgefield Co.
Aiken Co.
Fort Gorden
Prong Cr.
Spirit
Butler Cr.
Rocs Cr.
AUGUSTA
North Augusta
Clearwater
Little Horse Cr.
Langley
Horse
Bath
Warrenville
Graniteville
Kelly Cr.
Aiken
L. Spirit Cr.
New Savannah Bluff L&D
Richmond Co.
Burke Co.
McBean Cr.
Hollow Cr.
SAVANNAH RIVER PLANT
ATOMIC ENERGY COMMISSION
Boggy Gut Run
Tims Br.
Upper Three Runs Cr.
Tinker Cr.
Aiken Co.
Barnwell Co.
Fourmile Cr.
Savannah River
Pen Br.
Steel Br.
GA.
S.C.
Three Runs
Sweetwater Cr.
Barnwell Co.
Allendale Co.
Burke Co.
Screven Co.
Lower Mill Cr.
Barnwell
U.S. 301 Br.
Allendale
N
SCALE IN MILES
5 0 5 10

SAVANNAH RIVER STUDY AREA
GEORGIA - SOUTH CAROLINA

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY - AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

presumably above sources of pollution, however the reach of the creek above KC-21 must receive contamination from the residential sections of Aiken, South Carolina through which it flows.

On the basis of the fauna, Kelly Creek, at all stations studied, is classified as "semi-healthy". On the basis of the physical characteristics of the substrate the organic load is greater at the downstream stations, however characteristics of the fauna show that minimal levels of dissolved oxygen (>1.0 ppm) were present at all stations for a minimum one to two week period preceding this study.

Little Horse Creek flows in a southerly direction through Clearwater, South Carolina to its junction with Horse Creek. At the two stations studied, one above and one below Clearwater, South Carolina, Little Horse Creek ranged from 20 to 25 feet in width with a slight current. The substrate above Clearwater was composed principally of cleanly washed sand, gravel and silt, contrasted with an abundance of active sludge deposits at the downstream station (LHC-33). At station LHC-31, above Clearwater, the sediments contained 1.9 per cent carbon while below Clearwater at LHC-33 the sediments contained 6.1 per cent carbon (Table 1). On the basis of the flora and fauna Little Horse Creek above Clearwater is a clean stream as contrasted with the downstream station which was "grossly polluted" by wastes originating in the vicinity of Clearwater, South Carolina (Appendix II).

TABLE C-1

LEVELS OF CARBON AND CHROMIUM FOUND IN SEDIMENTS FROM THE SAVANNAH RIVER AND TRIBUTARIES

STATION	DATE SAMPLED	COD mg/kg	PERCENT CARBON	CHROMIUM mg/kg
S-73A	8/4/70	44,400	1.7	7
S-73E	"	7,900	0.3	<5
S-75A	"	80,600	3.0	
S-75E	"	17,700	0.7	
S-53A	"	6,160	0.2	12
S-53E	"	75,400	2.8	32
S-76A	"	155,600	5.8	670
S-76E	"	104,100	3.9	51
S-78A	"	69,100	2.6	38
S-78E	"	65,200	2.4	44
KC-21	9/2/70	6,650	0.2	
KC-22	"	108,900	4.1	
KC-24	"	79,700	3.0	
LHC-31	"	50,400	1.9	10
LHC-33	9/3/70	163,200	6.1	163
HC-35	"	71,900	2.7	990
BC-5	9/1/70	11,800	0.4	7
BC-6	"	103,200	3.9	81
LSC-94	"	52,400	2.0	
SC-10	"	4,250	0.2	
SC-11	9/2/70	52,000	1.9	
LTR-43	7/28/70	41,800	1.6	
LTR-43	"	10,400	0.4	
LTR-45	"	189,400	7.1	
LTR-45	"	381,300	14.3	

Horse Creek was sampled at a station (HC-35) 1.6 miles above its junction with the Savannah River and below all sources of pollution. The water was dark gray in color and the transparency as measured by a secchi disc was only six inches. The substrate was coarse sand overlain with thick deposits of sludge along both shorelines. These sludge deposits contained 990 ppm of chromium (Table 1). Sewage fungus was abundant on rocks and tree limbs and only three genera of pollution tolerant algae were found. No living macroinvertebrate organisms were found. Horse Creek from this station (HC-35) to its junction with the Savannah River is "grossly polluted" by wastes from upstream sources.

Butler Creek drains an area along the southern outskirts of Augusta, Georgia and enters the Savannah River just below the Savannah Bluff Lock and Dam at mile 186.9. Butler Creek was sampled at mile 2.4 adjacent to the New Savannah Road Bridge (BC-5) and at mile 0.2 just above the park at Savannah Bluff Lock and Dam (BC-6). At the upstream station (BC-5) the creek was clear with a sandy bottom and had a flora and fauna indicating that the creek at this point was subject to moderate levels of organic pollution (Appendix II). The creek at this station is classified as "semi-healthy". At the downstream station (BC-6) the water was gray in color with persistent foam and the substrate was covered with active deposits of decomposing sludge containing 3.9 per cent carbon and 81 ppm of chromium. Growths of "sewage fungus" were abundant and the bottom was red with extensive beds of sludge worms. On the basis of its physical appearance and the flora and fauna this lower reach of Butler Creek is classified as "polluted" (Appendix II).

Spirit Creek drains an area just south of Butler Creek and joins the Savannah River at mile 182.8, approximately five miles below Savannah Bluff Lock and Dam (Fig. 1). The creek was sampled three miles from the mouth of Highway 56 bridge (Station SC-10), and approximately 50 yards upstream from its junction with the river (SC-11). An additional station was sampled on Little Spirit Creek approximately 0.7 miles from the junction with Spirit Creek (LSC-94).

Little Spirit Creek is a shallow, sandy-bottomed stream which was sufficiently clear on September 1, 1970 that the bottom was visible at all depths. On the basis of the diverse flora and fauna, which included sensitive forms of stoneflies and caddis flies (Appendix II), this creek is classified as a "healthy" clean-water habitat.

At the upper station on Spirit Creek proper (SC-10) the substrate was clay overlain with sand and silt. On September 1, 1970 the creek was slightly turbid and the secchi disc could be observed at a maximum depth of 20 inches. The station supported a diverse and abundant flora and fauna (Appendix II), however sensitive forms were absent and the creek in this area is classified as "semi-healthy". Near the mouth of Spirit Creek at Station SC-11, the water was stained a dark tea color and the secchi disc could not be seen below 4.5 inches in depth. The creek channel was choked with fallen trees and logs, all of which were heavily coated with "sewage fungus". Only very tolerant forms of aquatic life were found at this station (Appendix II) and the creek is "grossly polluted".

Lower Three Runs Creek is an attractive stream draining a rural area of South Carolina on the southern edge of the Savannah River installation of the Atomic Energy Commission. Lower Three Runs Creek joins the Savannah River at mile 129.1 (Figure 3). Two stations were sampled on this creek, one above the effluent from the J. P. Stevens wool scouring plant and one below the entrance of the J. P. Stevens plant. The upper station (LTR-43) was adjacent to Highway 66 bridge at mile 6.5 (Figure 3). The creek at this station was approximately 30 feet wide, four feet in maximum depth, with very clear water having a faint tea color characteristic of coastal plain streams draining sandy, lowland swampy areas. This station supported a diverse community of macroinvertebrates including many forms intolerant of organic pollution (Appendix II) and the creek at this point is classified as "clean".

The lower station (LTR-45), at mile 4.0, was below the J. P. Stevens mill and adjacent to Highway 125 bridge. The water was a dark grey-brown color, and the bottom of the stream was covered with active sludge deposits. The average carbon content of two samples of the sediments was 10.7 per cent as contrasted with 1.0 per cent carbon at the upper station. The creek at this point supported a diverse community of invertebrates; however, none of the sensitive forms which were abundant at the upstream station were present. On the basis of the fauna present the creek at this station would be considered "polluted"; however, on the basis of physical appearance, the creek would fall in the category of "grossly polluted".

Savannah River Survey:

From river mile 202.7, adjacent to the North Augusta, South Carolina water intake downstream to river mile 128.1, near cut-off number 18B, a total of 20 stations was selected for study (Figure 1). The station at the North Augusta water intake was above all known waste sources in the Augusta area and the downstream stations were selected so that there was one "control" station immediately above each major potential waste source and from two to four stations at varying distances downstream from each source. It is important to recognize however that only the uppermost station (i.e. S-73 adjacent to the North Augusta, South Carolina water intake at river mile 202.7) is truly a control because all stations below the entrance of the first cut-off from the industrial canal at river mile 202.4 are subject to the individual and/or cumulative effects of all potential water sources which lie upstream of the station. The following discussion is based on the detailed description of the physical and biological characteristics of all stations studied as presented in Appendix III.

There was a distinct downstream change in the physical characteristics of the reach of the Savannah River studied and it can conveniently be divided into an "upper section" and a "lower section".

The "upper section", from the Augusta area downstream to Savannah Bluff Lock and Dam, was 150 to 200 yards in width with extensive shallow flats on both sides of the channel. These flats support dense beds of vascular plants dominated by waterweed (Elodea) and water milfoil (Myriophyllum). In the portion of the river adjacent to downtown Augusta, Georgia these beds were so dense as to make navigation difficult.

Water transparency, as measured by a secchi disc, in this upper section ranged from 41 inches to 64 inches except below Horse Creek where it was reduced, on the South Carolina side of the river, to 32 and 39 inches at Stations 76 and 79 respectively.

Except for the area immediately below Horse Creek, the substrate in the "upper section" was cleanly washed sand in the channel and sand overlain by silt on the flats. For a distance of at least 1000 yards below the mouth of Horse Creek the bottom of the left central portion of the river was coated with a slimy fibrous material high in organic matter and chromium. At Station 76, 100 yards below the mouth of Horse Creek, deposits ranged from 5.8 per cent carbon on the South Carolina side to 3.9 per cent carbon on the Georgia side of the river as compared with 0.7 to 1.7 per cent carbon at station 73 above all sources of pollution (Table 1). At the station below the mouth of Horse Creek the sludge deposits contained very high levels of chromium ranging from 51 ppm to 670 ppm, as compared with levels near the detection limit (5.0 ppm) at the upstream control station.

No information on the effects of high levels of chromium in sludge deposits are available, however, in water, chromium at levels much lower than those found in the Savannah River have been found to be toxic to forms of aquatic life ranging from fish to crustaceans and algae(6). Some crustaceans are killed at concentrations as low as 0.5 mg/l. Chromium at concentrations of 62.5 to 100 mg/l in water reduced the 5 day BOD by 50 per cent and concentrations of 5.0 mg/l has been found to cause a 50 per cent reduction in photosynthesis after 4 days. It is also reported that algae concentrate chromium by factors of 100 to 500 times the water concentration. The amount and effect of further biological magnification at higher levels in the food web is unknown but there is certainly a potential for rather drastic effects on the fish and other biological life in the reach of the Savannah River adjacent to Horse Creek.

The "upper section" receives wastes from downtown Augusta via Hawk's Gully and other outlets from the industrial canal, from the North Augusta, South Carolina sewer outfall, from Horse Creek and from the Columbia Nipro outfall ditch.

The "lower section", from Savannah Bluff Lock and Dam downstream to the Lower Three Runs area, was much narrower, averaging approximately 100 yards in width, with a swift current and steep, cut banks on one or both sides of the river. The banks on the inside of many bends were characterized by wide, shallow sand bars.

There were no extensive flats supporting beds of aquatic plants and the only extensive growths were adjacent to and between channel maintenance jetties where the current was reduced and silt deposits occurred. Except in the vicinity of jetties the bottom was cleanly washed sand with occasional outcrops of hard clay. The "lower section" receives wastes via Butler Creek, Spirit Creek and Lower Three Runs Creek.

Compared with the "upper section" transparency, as measured by a secchi disc, was somewhat reduced, ranging from 30 inches to 44 inches. For a distance of at least 100 yards below the mouth of Spirit Creek the highly colored water from Continental Can Corporation limited visibility of the secchi disc to 12 inches.

Sedgewick-Rafter counts of plankton grab samples from the Savannah River were quite low (Appendix II). There was a gradual downstream increase in plankton counts which ranged from lows of 50 cells per ml at the upper stations (73, 51 and 75) to a high of 297 cells per ml at station 47 which was just above the mouth of Lower Three Runs Creek in the "lower section" of the study area. Diatoms (particularly centrics) were the dominant component of the phytoplankton flora with increasing numbers of green and bluegreen algae appearing at downstream stations. This is the characteristic pattern of change in the algal community that is associated with water quality degradation.

The community of algae attached to glass slides (periphyton) was dominated by pennate diatoms at all stations studied (Appendix II). The upper control station (S-73) supported exclusively pennate diatoms, while downstream stations additionally supported varying numbers of green and bluegreen algae. The maximum total standing crop of periphyton and maximum standing crop of filamentous bluegreen algae were found at stations 52 and 75 respectively--both stations which were adjacent to downtown Augusta and one to two miles below all outlets from the industrial canal and the North Augusta, South Carolina sewer outfall. There was a drastic reduction in periphyton at the two stations below Spirit Creek, where the black liquor from Continental Can Corporation reduced light penetration.

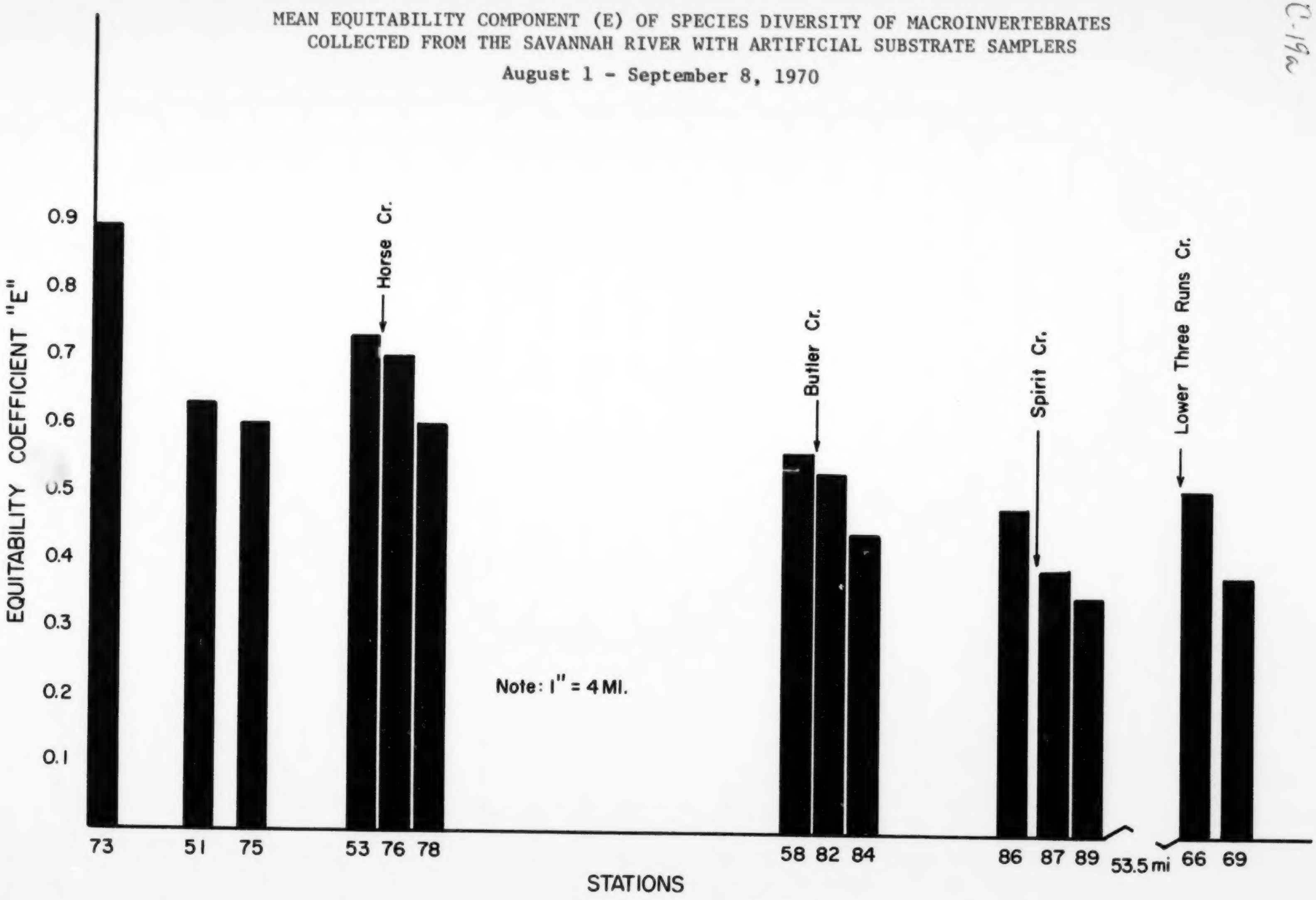
Using a variety of methods extensive collection of macroinvertebrates were made at most of the Savannah River stations. These collections revealed that the Savannah River at all stations sampled supported diverse communities of macroinvertebrates including forms intolerant of reduced oxygen levels associated with organic pollution (Appendix II). Differences between stations were related to natural differences in the physical characteristics of the habitat available to be sampled. At the station just below Horse Creek (S-76) which supported sludge deposits high in organic matter and chromium, orange peel dredge samples contained only one species of midge--*Chironomus attenuatus*. Over 75 per cent of the specimens of *Chironomus attenuatus* collected from these sludge deposits had morphological malformations such as deformed mandibles and labial plates. Numerous specimens of this species collected at station 53, above the mouth of Horse Creek, had no malformations.

The structure of the macroinvertebrate community which inhabited artificial substrate samplers, as measured by "E" the equitability component of species diversity, was characteristic of a healthy environment at station 73, adjacent to the North Augusta, South Carolina water supply intake (Fig. 5). There was a decreasing trend in "equitability" at downstream stations reaching a low at station 89 which is below the mouth of Spirit Creek and subject to the cumulative effects of all waste sources from the Augusta area. At both stations below Spirit Creek the equitability component was less than 0.4, a level characteristic of a semi-healthy bordering on polluted habitat. The increasing standing crops of macroinvertebrates inhabiting the samplers at the downstream stations is

FIGURE C-5

MEAN EQUITABILITY COMPONENT (E) OF SPECIES DIVERSITY OF MACROINVERTEBRATES
COLLECTED FROM THE SAVANNAH RIVER WITH ARTIFICIAL SUBSTRATE SAMPLERS

August 1 - September 8, 1970



also evidence of an enriched habitat below the Augusta area (Appendix II).

Diurnal dissolved oxygen studies were conducted at six stations in the "upper section" of the study area which supported dense growths of vascular aquatic plants. These six stations were established in sets of two for obtaining a measure of production and respiration using the two station diurnal curve technique described by Odum(7). Flow time between each set of two stations averaged close to one hour. Curves drawn from the field data were uninterpretable from the standpoint of calculating production because of apparent night time increases in oxygen in a downstream direction and concomitant decreasing oxygen during daylight hours. An examination of individual station curves reveal that the upper station (S-73), which was above all sources of pollution, had a typical diurnal curve with a peak in late afternoon and the trough at night (Fig. 6). However at downstream stations (S-75 and S-78), which were affected by wastes from Hawk's Gully and Horse Creek, the peak occurred at night and the trough near mid-day. In addition the downstream curves were considerably depressed in magnitude.

During the 24 hour period over which these dissolved oxygen data were collected it is concluded that: (1) The oxygen demanding waste load imposed on this section of the Savannah River was not constant, and (2) The waste load imposed was of sufficient magnitude to obscure the effects of the photosynthetic and respiratory activity of the dense growths of vascular aquatic plants which were present.

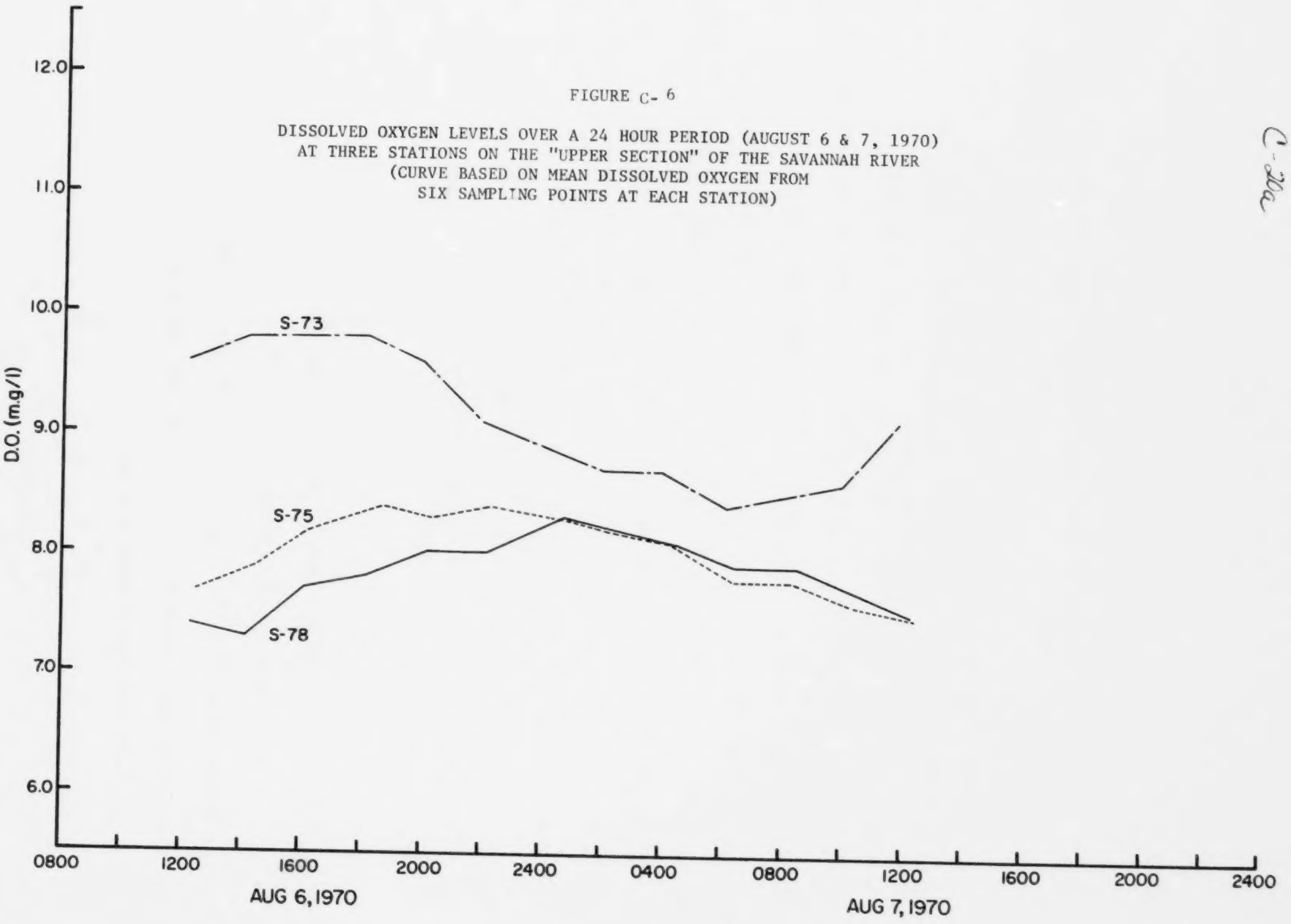


FIGURE C- 6

DISSOLVED OXYGEN LEVELS OVER A 24 HOUR PERIOD (AUGUST 6 & 7, 1970)
AT THREE STATIONS ON THE "UPPER SECTION" OF THE SAVANNAH RIVER
(CURVE BASED ON MEAN DISSOLVED OXYGEN FROM
SIX SAMPLING POINTS AT EACH STATION)

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(6) McKee, J. E. and Wolf. 1963. Water Quality Criteria. The Resources Agency of California, State Water Quality Control Board, Pub. number 3-A, 548 pp.

(7) Odum, H. T. 1956. Primary Production in Flowing Waters. Am. Soc. Limnology and Oceanography 1(2):102-117.

(8) Floyd, Monte and R. J. Ghelardi. 1964. A Table for Calculating the "Equitability" Component of Species Diversity. J. Animal Ecol. 33:217-225.

APPENDIX C-I

BIOLOGICAL METHODS

I. PLANKTON

Replicate one liter grab samples were collected at a depth of one foot and sufficient formalin was added to obtain a concentration of four (4) per cent. Total plankton counts were made in a Sedgewick-Rafter cell at a magnification of 200x.

II. PERIPHYTON

Periphyton samples were collected from the Savannah River by suspending five glass microscope slides in a plastic rack (Fig. 1) below a styrofoam float at a depth of approximately one foot. Collections from the tributary streams were made by attaching six replicate slides to bricks with "plasti-tak". All slides were retrieved at the end of a two week exposure period.

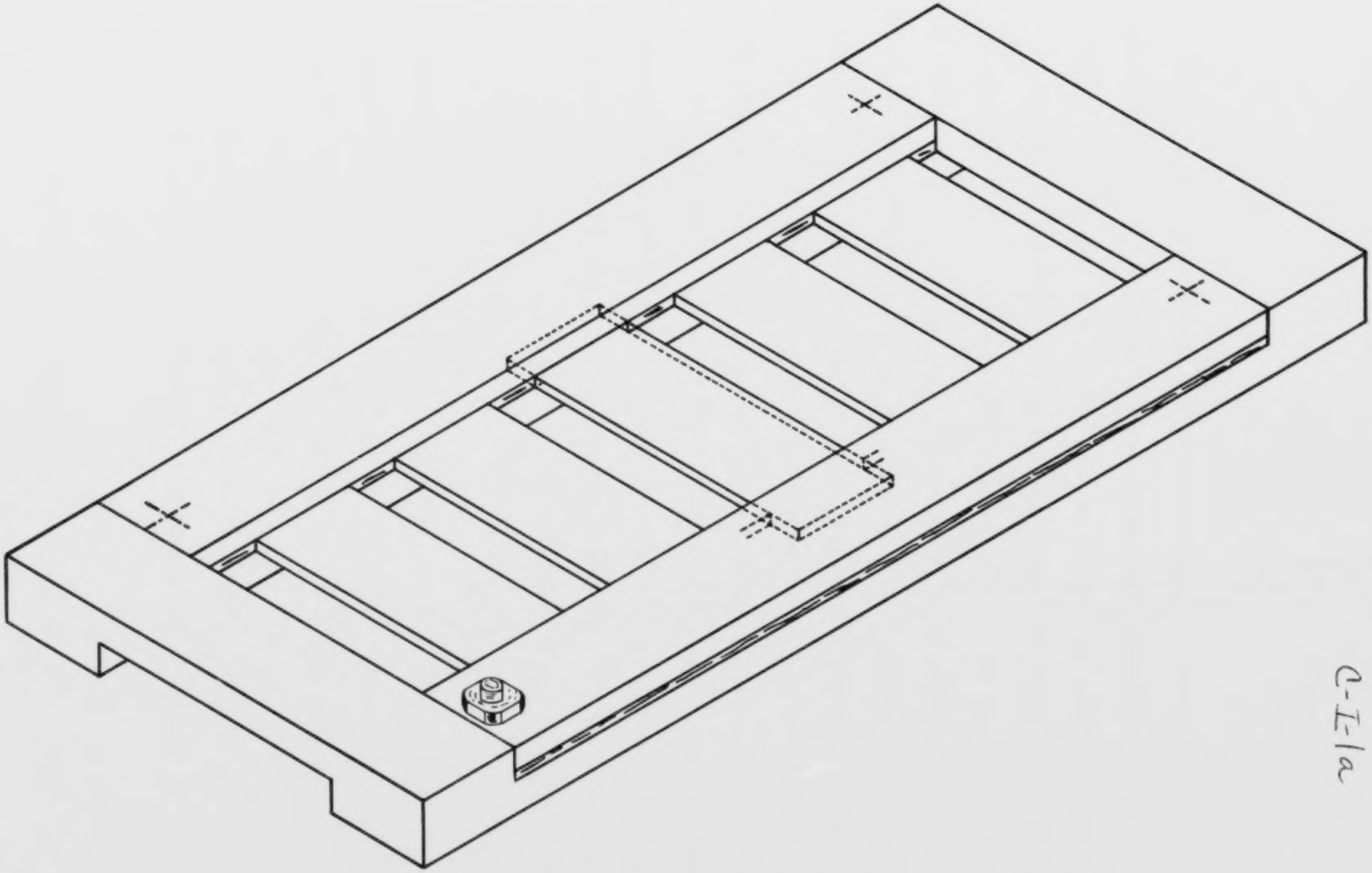
One slide from each set was preserved in 5 per cent formalin and the remaining slides were placed singly in jars containing a 90 per cent solution of acetone and frozen.

In the laboratory all material was scraped from the formalin preserved slides, dispersed in the original preservative by vigorous shaking, and additional four per cent formalin was added to obtain a total sample volume of 100 milliliters (ml). A Sedgwick-Rafter (S-R) count was made on a one ml aliquot of the sample and the cells per square millimeter (mm^2) of slide area was calculated as:

$$\text{Cells/mm}^2 = \frac{100 \times \text{S-R count (expressed in cells per ml)}}{\text{area of slide (mm}^2\text{)}}$$

FIGURE C-I-1

MICROSCOPE SLIDE RACK FOR COLLECTING PERIPHYTON



The acetone preserved slides were used for a determination of chlorophyll and biomass per square meter of slide surface. Chlorophyll was determined by reading the optical density of a centrifuged acetone extract at 665 and 750 mu using a Beckman Model B spectrophotometer. Corrections were made for physiologically inactive pigments by readings of the optical density of the extract before and after acidification with concentrated hydrochloric acid. Chlorophyll concentrations on individual slides were so low and variable that the data could not be interpreted and the results are not included as a part of this report.

Biomass was determined as ash-free weight by the difference between the dry weight and ashed weight of the centrifugate from the acetone preserved slides. The acetone extract was also evaporated to dryness and the ash-free weight of this material was added to the ash-free weight of the centrifugate.

III. MACROINVERTEBRATES[1]

Qualitative collections of aquatic macroinvertebrates were made with dip nets, grabs (Petersen, Ekman and Orange Peel) and by visual examination and hand picking from vascular plants and debris. Quantitative collections were made with artificial substrate samplers.

The artificial substrate samplers used were wire baskets containing 1½" to 3" diameter crushed limestone as described by Mason, et. al.(1)

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[1] Defined as all invertebrates retained by a 30 mesh screen.

Two replicate samplers were submerged at a depth of three feet at each station sampled by this method. After six weeks exposure the samplers were retrieved, the organisms removed and preserved in labelled vials of 70 per cent ethyl alcohol.

Data from these samplers were used to calculate indices of diversity. The two components of species diversity are:

1. Richness of species
2. Equitability in the distribution of individuals among the species

Diversity was calculated using the Shannon-Wiener function:

$$H = -\sum_{r=1}^{s} P_r \log_2 P_r$$

where H = mean diversity per individual, P = proportion of individuals belonging to the rth species and s = number of species.

Equitability (E) was calculated by the method of Lloyd and Ghelardi$^{(2)}$

"H", as calculated, is a combined measure of richness of species and equitability (evenness) of distribution of individuals among the species in the sample while "E" is a measure of equitability only. As calculated, "E" and "H" may range in value from zero to one, and from zero to 3.321928 log N respectively (N = total number of individuals). Maximum "H" may only be realized if each species is represented by one individual. If the distribution of individuals does approach equality of numbers then "E" may exceed one, however such an eventuality is rare.

Diversity serves as an excellent objective measure of environmental disturbance because any physical or chemical alteration, in the aquatic habitat, tends to favor certain species while reducing or eliminating those species which would normally be present under undisturbed conditions.

Richness of species may be considered as a measure of the structural diversity of the habitat and except under conditions of extreme degradation (septic conditions, toxic materials, lethal temperatures) is often relatively insensitive to subtle environmental changes. Equitability, or evenness of distribution of individuals among the species, is a sensitive measure of the stability of the physical and chemical characteristics of the environment.

By using a uniform substrate differences in diversity and equitability resulting from the physical structure of the habitat are kept to a minimum; hence reductions in these indices, particularly "E", may be attributed to differences in the chemical and/or physical characteristics of the aquatic environment.

REFERENCES

(1) Mason, William T., Jr., Anderson, J. B., and Georgia E. Morrison. 1967. A limestone-filled artificial substrate sampler-float unit for collecting macroinvertebrates from large streams. Prog. Fish. Cult. 29(2):74.

(2) Lloyd, Monte and R. J. Ghelardi. 1964. A table for calculating the "equitability" component of species diversity. J. Animal Ecol. 33:217-225.

APPENDIX II

TABULAR SUMMARIES OF BIOLOGICAL DATA

Table I. Macroinvertebrates Collected from the Savannah River and Tributaries During August and September, 1970.

Table II. Plankton Counts (cells/ml) from the Middle Savannah River (August 1-4, 1970).

Table III. Attached Algae per square millimeter (mm^2) of Slide Surface from Savannah River Stations (slides exposed from August 1, 1970 through September 1, 1970).

Table IV. Plankton Counts (cells/ml) from Lower Three Runs Creek and from Savannah River in Vicinity of Lower Three Runs Creek (July 28, 1970 - July 30, 1970).

Table V. Qualitative Collections of Attached Algae from Stations on the Savannah River and Tributaries (August - September, 1970).

Table VI. Standing Crop and Diversity of Macroinvertebrates Collected with Artificial Substrate Samplers from the Savannah River (August 1, 1970 - September 8, 1970).

TABLE C-I-I

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970[1,2]

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
DIPTERA																				
Chironomidae																				
Orthocladinae																				
Brillia par	-	P	-	-	-	-	P	P	-	-	-	-	-	-	-	P	P	P	-	-
Nanocladius alternantherae	-	P	P	P	P	P	P	P	P	P	P	P	P	P	-	C	P	C	C	P
Nanocladius sp. 1 of Roback	-	-	-	-	C	-	P	-	-	-	-	-	-	-	-	-	-	P	P	-
Nanocladius nr. *sordens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	P	-
Nanocladius sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus bicinctus	P	P	P	P	C	P	C	P	-	P	P	P	-	P	-	C	A	A	A	A
Cricotopus slossonae	P	P	P	-	P	-	C	-	-	P	-	P	P	P	-	P	P	P	C	C
Cricotopus ceris	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-	-
Cricotopus trifasciatus	-	-	-	-	-	-	-	P	-	-	-	-	-	P	-	-	-	-	-	P
Cricotopus sp. 2 of Roback	P	P	-	-	-	-	C	P	-	P	P	P	C	C	-	P	P	P	P	A
Trichocladius robacki	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichocladius nr. sp. 1 of Roback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Trichocladius nr. sp. 2 of Roback	-	-	-	-	-	-	-	P	-	P	-	-	-	-	-	P	-	-	-	-
Psectrocladius sp. B of Beck	P	P	C	P	P	P	P	C	P	P	P	P	P	P	-	P	-	P	P	P
Orthocladius carlatus	-	-	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardiocladius obscurus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corynoneura (*Thienemanniella*) sp. 2 of Roback	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Thienemanniella*) *xena*	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	P	-	-

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1. Column Headings: A is the east sixth point on transect, E is the west sixth point.
2. Abundance Rating: P equals present (<10), C equals common (10-50), A equals abundant (>50).

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
DIPTERA																		
Chironomidae																		
Orthocladinae																		
Brillia par	-	-	-	-	P	-	-	-	-	P	-	-	-	-	-	-	P	-
Nanocladius alternantherae	C	C	P	P	P	-	-	P	P	A	C	P	-	P	P	-	P	P
Nanocladius sp. 1 of Roback	P	P	-	P	C	-	-	-	C	P	A	P	-	C	-	-	P	C
Nanocladius nr. *sordens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nanocladius sp.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Cricotopus bicinctus	A	A	C	A	A	-	-	C	A	C	A	P	-	C	C	-	P	C
Cricotopus slossonae	C	C	P	P	-	-	-	P	P	C	P	-	-	-	P	-	-	-
Cricotopus ceris	P	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus trifasciatus	P	P	-	-	-	-	-	-	P	P	P	-	-	-	-	-	-	-
Cricotopus sp. 2 of Roback	P	C	-	P	P	-	-	-	P	P	C	-	-	-	-	-	P	-
Trichocladius robacki	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichocladius nr. sp. 1 of Roback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichocladius nr. sp. 2 of Roback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psectrocladius sp. B of Beck	P	P	-	-	-	-	-	-	P	P	-	P	-	-	-	-	-	-
Orthocladius carlatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardiocladius obscurus	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Corynoneura (*Thienemanniella*) sp. 2 of Roback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Thienemanniella*) *xena*	-	P	-	-	-	-	-	-	P	-	A	-	-	-	P	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
DIPTERA													
Chironomidae													
Orthocladinae													
Brillia par	-	-	-	-	-	-	-	-	-	-	-	-	-
Nanocladius alternantherae	-	-	-	-	P	-	P	-	-	-	-	-	-
Nanocladius sp. 1 of Roback	P	-	-	-	P	-	-	-	-	-	P	-	-
Nanocladius nr. sordens	-	-	-	-	-	-	-	-	-	-	-	-	-
Nanocladius sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus bicinctus	-	-	P	P	C	-	P	-	P	-	-	-	-
Cricotopus slossonae	P	-	-	-	P	-	-	-	P	-	P	-	-
Cricotopus ceris	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus trifasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus sp. 2 of Roback	-	-	-	-	P	-	-	-	-	-	P	-	-
Trichocladius robacki	P	-	P	P	C	-	-	-	-	-	C	-	-
Trichocladius nr. sp. 1 of Roback	P	-	-	-	-	-	-	-	-	-	-	-	-
Trichocladius nr. sp. 2 of Roback	-	-	-	-	-	-	-	-	-	-	-	-	-
Psectrocladius sp. B of Beck	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthocladius carlatus	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardiocladius obscurus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Corynoneura (Thienemanniella) sp. 2 of Roback	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Thienemanniella) xena	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
C. (*Thienemanniella*) sp. a of Roback	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
C. (*Corynoneura*) *celeripes*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined genus nr. *Corynoneura*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanypodinae																				
Pentaneura (*Pentaneura*) *inculta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. *carneosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. (*Nilotanypus*) sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-
P. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ablabesmyia *janta*	P	P	C	C	P	C	P	P	P	P	P	P	-	-	P	P	P	-	-	-
A. *hauberi*	-	-	P	-	-	-	-	-	-	P	P	-	P	-	-	P	-	-	-	-
A. *mallochi*	P	C	P	C	P	C	P	C	P	C	P	C	P	P	-	P	P	P	C	P
A. *ornata*	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
A. *auriensis*	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A. *peleensis*	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
Procladius *culiciformis*	-	-	P	-	-	-	P	-	-	-	-	-	C	-	-	-	-	-	-	-
P. nr. *adumbratus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anatopynia (*Psectrotanypus*) *dyari*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A. (*Psectrotanypus*) sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clintoanypus *thoracicus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sp.	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conchapelopia *fasciata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sp.	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-
Labrundinia *floridana*	P	P	P	P	P	C	P	P	P	P	P	P	-	-	-	P	-	P	P	P

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
C. (Thienemanniella) sp. a of Roback	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Corynoneura) celeripes	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Undetermined genus nr. Corynoneura	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Tanypodinae																		
Pentaneura (Pentaneura) inculta	-	-	-	-	-	-	-	-	-	P	-	P	-	P	-	-	P	P
P. carneosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. (Nilotanypus) sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ablabesmyia janta	-	P	P	P	P	-	-	-	-	P	P	P	-	P	P	-	P	P
A. hauberi	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-
A. mallochi	P	C	P	P	-	-	-	P	P	C	P	P	-	-	-	-	-	-
A. ornata	-	-	-	-	-	-	-	-	-	-	P	P	-	-	-	-	-	-
A. auriensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A. peleensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Procladius culiciformis	P	-	-	-	-	-	-	-	-	P	P	-	-	-	-	-	-	-
P. nr. adumbratus	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anatopynia (Psectrotanypus) dyari	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A. (Psectrotanypus) sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clintoanypus thoracicus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conchapelopia fasciata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sp.	-	-	P	-	P	-	-	-	P	P	P	P	-	-	-	-	-	P
Labrundinia floridana	P	P	P	P	-	-	-	-	-	P	P	P	-	-	P	-	P	P

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
C. (Thienemanniella) sp. a of Roback	P	-	-	-	-	-	-	-	-	-	-	-	-
C. (Corynoneura) celeripes	P	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined genus nr. Corynoneura	P	-	-	-	-	-	-	-	-	-	-	-	-
Tanypodinae													
Pentaneura (Pentaneura) inculta	-	-	-	-	-	-	P	-	-	-	-	-	-
P. carneosa	-	-	-	-	-	-	-	-	-	-	-	-	P
P. (Nilotanypus) sp.	P	-	-	-	-	-	-	-	-	-	-	-	-
P. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ablabesmyia janta	-	-	-	-	-	-	-	-	P	-	P	-	P
A. hauberi	-	-	-	-	-	-	-	-	P	-	-	-	-
A. mallochi	-	-	-	-	-	-	-	-	-	-	-	-	-
A. ornata	-	-	-	-	-	-	-	-	-	-	-	P	-
A. auriensis	P	-	-	-	-	-	-	-	-	-	-	-	-
A. peleensis	-	-	-	-	-	-	-	-	-	-	-	-	-
Procladius culiciformis	-	-	-	C	-	-	C	-	-	-	-	P	-
P. nr. adumbratus	-	-	-	-	-	-	-	-	-	-	-	-	-
Anatopynia (Psectrotanypus) dyari	-	-	-	-	-	-	-	-	-	-	-	-	C
A. (Psectrotanypus) sp.	-	-	-	-	-	-	-	P	-	-	-	-	-
Clintoanypus thoracicus	-	-	-	-	-	-	-	-	P	-	-	P	-
C. sp.	-	-	-	P	-	-	-	-	-	-	-	-	-
Conchapelopia fasciata	-	-	-	-	-	-	-	-	-	-	-	-	P
C. sp.	C	-	P	-	-	-	-	-	-	-	P	P	-
Labrundinia floridana	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
Tanypus stellatus	-	-	-	-	-	-	C	P	P	-	-	P	A
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	P
Podonominae													
Undetermined genus nr. Podonomus	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined genus nr. Boreochlis	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironominae													
Chironomus (Chironomus) fulvipilus	-	-	-	-	-	-	-	P	P	P	-	-	C
C. (Chironomus) attenuatus	-	-	-	-	-	-	P	-	-	A	-	P	P
C. (Chironomus) crassicaudatus	-	-	-	-	-	-	-	P	-	-	-	-	-
C. (Chironomus) prasinus	-	-	-	-	-	-	-	-	-	-	-	-	P
C. (Dicrotendipes) modestus	-	-	-	-	-	-	-	-	P	-	-	P	-
C. (Dicrotendipes) incurvus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Dicrotendipes) neomodestus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Cryptochironomus) collator	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Cryptochironomus) galeator	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Cryptochironomus pectinatellae	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Cryptochironomus) carinatus	-	-	-	-	-	-	-	-	P	-	-	-	-
C. (Cryptochironomus) fulvus	P	-	P	P	-	-	-	-	-	-	P	P	-
C. (Cryptochironomus) boydi	-	-	-	-	-	-	-	-	-	-	-	P	-
C. (Cryptochironomus) ponderosus	-	-	-	-	-	-	-	-	P	-	-	-	-
C. (Cryptochironomus) sp. 4 of Roback	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Cryptochironomus) sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Endochironomus) nigricans	-	-	-	-	-	-	-	-	P	-	-	-	-
C. (Tribelos) jucundus	-	-	-	-	-	-	-	-	-	-	-	P	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Tanypus stellatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Podonominae																				
Undetermined genus nr. *Podonomus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined genus nr. *Boreochlis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironominae																				
Chironomus (*Chironomus*) *fulvipilus*	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	P	-	-	-	P
C. (*Chironomus*) *attenuatus*	-	-	-	-	-	-	C	-	C	P	P	-	P	-	-	-	-	-	-	-
C. (*Chironomus*) *crassicaudatus*	-	-	-	-	-	-	P	-	P	-	-	-	-	-	P	-	-	-	-	-
C. (*Chironomus*) *prasinus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Dicrotendipes*) *modestus*	P	-	-	-	-	-	P	P	P	P	-	-	P	-	-	P	-	-	-	-
C. (*Dicrotendipes*) *incurvus*	-	-	P	-	-	-	-	C	-	C	-	P	P	P	P	P	-	-	-	P
C. (*Dicrotendipes*) *neomodestus*	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Cryptochironomus*) *collator*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Cryptochironomus*) *galeator*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Cryptochironomus*) *pectinatellae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Cryptochironomus*) *carinatus*	-	-	-	P	P	-	P	P	P	P	C	-	-	C	P	C	C	P	C	P
C. (*Cryptochironomus*) *fulvus*	-	-	-	-	-	-	C	-	-	-	-	-	P	-	-	-	-	-	-	-
C. (*Cryptochironomus*) *boydi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Cryptochironomus*) *ponderosus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Cryptochironomus*) sp. 4 of Roback	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Cryptochironomus*) sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Endochironomus*) *nigricans*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (*Tribelos*) *jucundus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-85		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Tanypus stellatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Podonominae																		
Undetermined genus nr. Podonomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Undetermined genus nr. Boreochlis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Chironominae																		
Chironomus (Chironomus) fulvipilus	P	P	-	P	-	-	-	-	-	P	-	P	-	-	-	-	-	-
C. (Chironomus) attenuatus	-	-	-	-	-	-	-	P	-	P	P	P	-	-	-	-	-	-
C. (Chironomus) crassicaudatus	-	-	-	-	-	-	-	-	P	C	-	-	-	-	-	-	-	-
C. (Chironomus) prasinus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
C. (Dicrotendipes) modestus	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Dicrotendipes) incurvus	P	P	-	-	P	-	-	-	-	P	-	-	-	-	-	-	-	-
C. (Dicrotendipes) neomodestus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Cryptochironomus) collator	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Cryptochironomus) galeator	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Cryptochironomus) pectinatellae	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	P	-
C. (Cryptochironomus) carinatus	C	A	C	P	P	-	-	P	P	A	P	C	-	-	-	-	P	P
C. (Cryptochironomus) fulvus	-	-	P	-	-	-	-	P	-	-	P	-	-	-	-	-	-	-
C. (Cryptochironomus) boydi	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Cryptochironomus) ponderosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Cryptochironomus) sp. 4 of Roback	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
C. (Cryptochironomus) sp.	-	-	-	-	-	-	-	-	-	-	P	P	-	-	-	-	P	-
C. (Endochironomus) nigricans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. (Tribelos) jucundus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
C. (Xenochironomus) xenolabis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Demicryptochironomus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microchironomus sp.	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
Pedionomus beckae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glyptotendipes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cryptotendipes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (Polypedilum) illinoense	P	C	P	P	P	P	P	P	P	P	P	P	P	C	P	C	P	A	P	C
P. (Polypedilum) nr. illinoense	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. (Polypedilum) halterale	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
P. (Polypedilum) fallax	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. (Polypedilum) scalaenum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. (pentapedilum) nr. sordens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenochironomus hilaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nr. hilaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Chironomini sp. c of Roback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. Undetermined sp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. Undetermined sp. II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. Undetermined sp. III	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus (Rheotanytarsus) exiguus	P	-	P	P	P	-	P	-	-	-	-	-	-	-	-	-	C	P	C	-
T. (Tanytarsus) varelus	-	P	P	P	-	P	C	C	P	A	-	C	-	P	P	C	P	P	P	-
T. (Tanytarsus) guerlus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. (Tanytarsus) glabrescens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. (Tanytarsus) nr. boiemica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. sp. A of Beck	-	-	-	-	-	-	-	P	-	P	-	P	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
C. (Xenochironomus) xenolabis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	P	-
Demicryptochironomus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microchironomus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedionomus beckae	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Glyptotendipes sp.	-	-	P	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Cryptotendipes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (Polypedilum) illinoense	P	C	P	P	P	-	-	P	C	C	A	P	-	P	C	-	P	C
P. (Polypedilum) nr. illinoense	-	P	-	-	-	-	-	-	-	P	-	-	-	C	-	-	P	-
P. (Polypedilum) halterale	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
P. (Polypedilum) fallax	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. (Polypedilum) scalaenum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. (Pentapedilum) nr. sordens	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Stenochironomus hilaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
S. nr. hilaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
S. sp.	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Chironomini sp. c of Roback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomini Undetermined sp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. Undetermined sp. II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. Undetermined sp. III	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus (Rheotanytarsus) exiguus	P	P	C	C	C	-	-	-	C	A	A	C	-	A	C	-	A	A
T. (Tanytarsus) varelus	P	P	P	P	-	-	-	P	-	P	-	P	-	-	-	-	-	-
T. (Tanytarsus) guerlus	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
T. (Tanytarsus) glabrescens	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
T. (Tanytarsus) nr. boiemica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. sp. A of Beck	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	P	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
C. (Xenochironomus) xenolabis	-	-	-	-	-	-	-	-	-	-	-	-	-
Demicryptochironomus sp.	P	-	-	-	-	-	-	-	P	-	-	-	-
Microchironomus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedionomus beckae	-	-	-	-	-	-	-	-	-	-	-	-	-
Glyptotendipes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Cryptotendipes sp.	-	-	P	-	-	-	-	-	-	-	-	P	-
Polypedilum (Polypedilum) illinoense	P	-	P	P	C	-	-	P	C	-	P	-	A
P. (Polypedilum) nr. illinoense	P	-	-	-	-	-	-	-	P	-	C	-	-
P. (Polypedilum) halterale	P	-	P	-	-	-	-	-	P	-	-	-	-
P. (Polypedilum) fallax	P	-	P	P	-	-	P	-	-	-	-	-	C
P. (Polypedilum) scalaenum	-	-	P	-	-	-	-	-	-	-	-	-	-
P. (Pentapedilum) nr. sordens	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenochironomus hilaris	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nr. hilaris	-	-	-	-	-	-	-	-	-	-	-	-	-
S. sp.	C	-	-	-	-	-	-	-	-	-	P	-	-
Chironomini sp. c of Roback	P	-	-	-	-	-	-	-	-	-	-	-	-
C. Undetermined sp. I	P	-	-	-	-	-	-	-	-	-	-	-	-
C. Undetermined sp. II	P	-	-	-	-	-	-	-	-	-	-	-	-
C. Undetermined sp. III	P	-	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus (Rheotanytarsus) exiguus	C	-	-	-	C	-	P	-	P	-	C	-	-
T. (Tanytarsus) varelus	-	-	-	-	-	-	-	-	-	-	-	-	-
T. (Tanytarsus) guerlus	-	-	-	-	-	-	-	-	-	-	-	-	-
T. (Tanytarsus) glabrescens	-	-	-	-	-	-	-	-	-	-	-	-	-
T. (Tanytarsus) nr. boiemica	-	-	-	-	-	-	-	-	-	-	-	-	-
T. sp. A of Beck	P	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
T. sp. B. of Beck	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
T. (Macrosandalum) sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phaenopsectra flavipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zavrelia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceratopogonidae																				
Palpomyia sp.	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Probezzia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Culicoides sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dasyhelea traverae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	P	-	P	-	-	-	P	C	-	C	-	-	-	-	-	-	-	-	-	-
Simulidae																				
Prosimulium sp.	P	P	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simulium sp.	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Empididae																				
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-
Culicidae																				
Culex erraticus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaoborus punctipennis	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
T. sp. B. of Beck	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. (Macrosandalum) sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phaenopsectra flavipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zavrelia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceratopogonidae																		
Palpomyia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Probezzia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Culicoides sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dasyhelea traverae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	P	P	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Simulidae																		
Prosimulium sp.	-	-	-	-	P	-	-	-	-	-	A	C	-	A	C	-	C	A
Simulium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Empididae																		
Undetermined sp.	-	P	P	P	P	-	-	-	P	P	A	-	-	-	-	-	P	P
Culicidae																		
Culex erraticus	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Chaoborus punctipennis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
T. sp. B of Beck	P	-	P	-	-	-	-	-	P	-	-	P	-
T. (Macrosandalum) sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Phaenopsectra flavipes	-	-	-	-	-	-	-	-	-	-	-	P	P
Zavrelia sp.	P	-	-	-	-	-	-	-	-	-	-	-	-
Ceratopogonidae													
Palpomyia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Probezzia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Culicoides sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Dasyhelea traverae	-	-	-	-	-	-	-	-	-	-	-	-	P
Undetermined sp.	P	-	P	-	-	-	-	-	P	-	-	-	A
Simulidae													
Prosimulium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Simulium sp.	P	-	-	-	C	-	-	-	-	-	-	-	-
Empididae													
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Culicidae													
Culex erraticus	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaoborus punctipennis	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Tipulidae																				
Tipula sp.	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnophora sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limonia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Hexatoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sciomyzidae																				
Undetermined sp.	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-
Stratiomyidae																				
Euparyphus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Tabanidae																				
Crysops sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psychodidae																				
Pericoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-
Ephydridae																				
Brachydeutera sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMEROPTERA																				
Baetidae																				
Baetis intercalaris	P	-	P	P	A	P	C	-	-	-	P	P	-	-	P	-	C	C	C	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Tipulidae																		
Tipula sp.	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnophora sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limonia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexatoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sciomyzidae																		
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stratiomyidae																		
Euparyphus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tabanidae																		
Crysops sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Psychodidae																		
Pericoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephydridae																		
Brachydeutera sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMEROPTERA																		
Baetidae																		
Baetis intercalaris	-	P	-	P	P	-	-	P	P	P	P	-	-	-	P	-	P	-

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
Tipulidae													
Tipula sp.	-	-	-	-	P	-	-	-	P	-	-	-	-
Limnophora sp.	-	P	-	-	-	-	-	-	-	-	-	-	-
Limonia sp.	-	-	-	-	-	-	-	P	-	-	-	-	-
Hexatoma sp.	P	-	-	-	-	-	-	-	-	-	-	-	-
Sciomyzidae													
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Stratiomyidae													
Euparyphus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Tabanidae													
Crysops sp.	-	-	-	-	-	-	P	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	P
Psychodidae													
Pericoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephydridae													
Brachydeutera sp.	P	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	P	-	-	-	-	-
EPHEMEROPTERA													
Baetidae													
Baetis intercalaris	P	-	-	-	-	-	-	-	C	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
B. spinosus	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Pseudocloeon alachua	-	-	P	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	P	-
Cloeon sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-
Callibaetis floridanus	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Ameletus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isonychia pictipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I. sp. B of Berner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	P	-
Caenidae																				
Caenis hilaris	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tricorythodes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Ephemeridae																				
Hexagenia munda marilandica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heptageniidae																				
Heptagenia flavescens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenonema smithae	C	P	C	-	A	P	C	P	-	P	-	P	-	P	-	-	P	P	P	-
S. exiguum	-	-	P	P	C	-	P	P	-	-	-	P	-	-	-	-	-	-	-	-
TRICHOPTERA																				
Undetermined sp.	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
B. spinosus	-	-	-	-	-	-	-	-	-	-	P	P	-	-	-	-	-	-
Pseudocloeon alachua	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Cloeon sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Callibaetis floridanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ameletus sp.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Isonychia pictipes	-	-	-	-	-	-	-	-	-	-	A	C	-	A	-	-	A	A
I. sp. B of Berner	-	-	-	-	-	-	-	-	-	-	A	-	-	-	-	-	C	-
Undetermined sp.	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenidae																		
Caenis hilaris	-	-	-	-	-	-	-	-	-	-	P	P	-	P	P	-	P	C
Tricorythodes sp.	-	-	-	-	-	-	-	-	-	-	P	P	-	C	P	-	C	-
Ephemeridae																		
Hexagenia munda marilandica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heptageniidae																		
Heptagenia flavescens	-	-	-	-	-	-	-	-	-	-	C	-	-	P	-	-	-	-
Stenonema smithae	-	P	-	-	-	-	-	-	P	-	P	P	-	C	-	-	C	P
S. exiguum	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	P	-
TRICHOPTERA																		
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
B. spinosus	-	-	-	-	-	-	C	-	-	-	-	-	-
Pseudocloeon alachua	-	-	-	-	-	-	-	-	-	-	-	-	-
Cloeon sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Callibaetis floridanus	-	-	-	-	-	-	-	-	-	-	-	-	-
Ameletus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Isonychia pictipes	-	-	-	-	-	-	-	-	-	-	-	-	-
I. sp. B of Berner	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenidae													
Caenis hilaris	-	-	-	-	-	-	-	-	P	-	-	-	-
Tricorythodes sp.	-	-	-	-	-	-	-	-	-	-	-	P	-
Ephemeridae													
Hexagenia munda marilandica	-	-	-	-	-	-	-	-	-	-	P	P	-
Heptageniidae													
Heptagenia flavescens	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenonema smithae	C	-	-	C	C	-	-	-	C	-	P	P	-
S. exiguum	-	-	-	-	-	-	-	-	P	-	-	-	-
TRICHOPTERA													
Undetermined sp.	P	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Hydroptilidae																				
Agraylea multipunctata	P	C	C	-	P	P	C	P	-	P	-	-	-	-	-	-	P	-	C	-
Oxyethira sp.	P	C	P	P	-	P	P	A	C	-	P	-	-	P	-	-	-	-	P	-
Agraylea sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnephilidae																				
Pseudostenophylax sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsychidae																				
Hydropsyche sp.	-	-	-	-	A	P	C	-	-	P	-	P	-	-	-	-	C	P	C	-
Cheumatopsyche sp.	P	P	-	-	A	-	C	-	-	P	-	-	-	-	-	-	-	P	-	-
Macronemum sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M. carolina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M. zebratum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Philopotamidae																				
Chimarra socia	P	-	-	-	A	-	C	-	-	-	-	-	-	-	-	-	-	-	P	-
Brachycentridae																				
Brachycentrus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptoceridae																				
Oecetis sp.	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptocella candida	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Triaenodes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Athripsodes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLC C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Hydroptilidae																		
Agraylea multipunctata	C	-	P	-	-	-	-	-	P	-	P	P	-	P	P	-	-	P
Oxyethira sp.	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Agraylea sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Limnephilidae																		
Pseudostenophylax sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsychidae																		
Hydropsyche sp.	-	P	P	P	A	-	-	P	A	A	A	P	-	A	P	-	P	C
Cheumatopsyche sp.	-	-	-	-	-	-	-	P	C	-	A	A	-	A	-	-	A	A
Macronemum sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	P
M. carolina	-	P	-	-	-	-	-	-	-	P	C	A	-	A	-	-	P	A
M. zebratum	-	-	-	-	-	-	-	-	-	-	P	P	-	C	-	-	-	C
Philopotamidae																		
Chimarra socia	-	-	-	-	P	-	-	-	-	P	A	A	-	A	-	-	C	A
Brachycentridae																		
Brachycentrus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptoceridae																		
Oecetis sp.	-	-	-	-	-	-	-	P	-	P	C	C	-	C	-	-	P	C
Leptocella candida	P	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	P	P
Triaenodes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Athripsodes sp.	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
Hydroptilidae													
Agraylea multipunctata	-	-	-	-	-	-	-	-	P	-	-	-	-
Oxyethira sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Agraylea sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnephilidae													
Pseudostenophylax sp.	P	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsychidae													
Hydropsyche sp.	P	-	-	-	-	-	-	-	P	-	P	-	-
Cheumatopsyche sp.	P	-	P	P	P	P	-	-	C	-	C	-	-
Macronemum sp.	P	-	-	-	-	-	-	-	-	-	-	-	-
M. carolina	C	-	-	-	-	-	-	-	-	-	A	-	-
M. zebratum	P	-	-	-	-	-	-	-	-	-	C	-	-
Philopotamidae													
Chimarra socia	P	-	-	-	-	-	-	-	-	-	-	-	-
Brachycentridae													
Brachycentrus sp.	-	-	-	-	-	-	-	-	-	-	P	-	-
Leptoceridae													
Oecetis sp.	P	-	-	-	-	-	-	-	-	-	-	-	-
Leptocella candida	-	-	-	-	-	-	-	-	-	-	P	-	-
Triaenodes sp.	-	-	-	-	-	-	-	-	-	-	-	P	-
Athripsodes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Psychomyiidae																				
Neureclipsis crepuscularis	P	-	P	-	A	P	C	-	-	P	-	-	-	-	-	-	P	-	P	-
PLECOPTERA																				
Pternonarcidae																				
Pteronarcys sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peltoperlidae																				
Peltoperla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perlidae																				
Acroneuria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phasganophora capitata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perlodidae																				
Isoperla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ODONATA																				
Gomphidae																				
Progomphus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gomphus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aeschinidae																				
Nasiaeschna sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boyeria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Psychomyiidae																		
Neureclipsis crepuscularis	P	-	P	-	-	-	-	-	-	-	A	A	-	A	-	-	A	A
PLECOPTERA																		
Pternonarcidae																		
Pteronarcys sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peltoperlidae																		
Peltoperla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perlidae																		
Acroneuria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phasganophora capitata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perlodidae																		
Isoperla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ODONATA																		
Gomphidae																		
Progomphus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gomphus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aeschnidae																		
Nasiaeschna sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boyeria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
Psychomyiidae													
Neureclipsis crepuscularis	P	-	-	-	-	-	-	-	-	-	-	P	-
PLECOPTERA													
Pternonarcidae													
Pteronarcys sp.	P	-	-	-	-	-	-	-	-	-	-	-	-
Peltoperlidae													
Peltoperla sp.	P	-	-	-	-	-	-	-	-	-	-	-	-
Perlidae													
Acroneuria sp.	-	-	-	-	-	-	-	-	-	-	P	-	-
Phasganophora capitata	P	-	-	-	-	-	-	-	-	-	P	-	-
Perlodidae													
Isoperla sp.	P	-	-	-	-	-	-	-	-	-	-	-	-
ODONATA													
Gomphidae													
Progomphus sp.	P	-	-	P	-	-	P	-	-	-	-	-	-
Gomphus sp.	-	-	P	-	-	-	-	-	-	-	-	P	-
Aeschnidae													
Nasiaeschna sp.	-	-	-	-	-	-	-	-	-	-	-	-	P
Boyeria sp.	P	-	P	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Libellulidae																				
Neurocordulia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Macromia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erythemis sp.	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-
Pachydiplax sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Orthemis sp.	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-
Epicordulia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sympetrum sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-
Coenagrionidae																				
Coenagrion sp.	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-
Enallagma sp.	P	-	P	P	-	-	-	C	-	-	-	-	-	-	-	-	-	-	P	-
Ischnura sp.	-	P	-	P	-	-	-	P	C	P	-	-	-	P	-	-	-	P	-	-
Argia sp.	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	P	P	-	-	-	-	-	-	P	-	-	-	-	P	-	-	-	-	P	-
Calopterygidae																				
Calopteryx sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hetaerina sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COLEOPTERA																				
Gyrinidae																				
Gyrinus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Gyretes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dineutus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-84 A	S-84 E	S-86 A	S-86 E	S-87 A	S-87 E	S-88 A	S-88 E	S-89 A	S-89 E	S-47 A	S-47 E	S-66 A	S-66 E	S-68 A	S-68 E	S-69 A	S-69 E
Libellulidae																		
Neurocordulia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Macromia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erythemis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pachydiplax sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthemis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epicordulia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sympetrum sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coenagrionidae																		
Coenagrion sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Enallagma sp.	-	-	-	-	-	-	-	P	P	-	P	-	-	-	?	-	-	-
Ischnura sp.	P	-	-	P	-	-	-	-	P	P	P	-	-	-	-	-	-	-
Argia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	P	-	P	P	-	-	-	-	P	P	-	-	-	-	-	-	-	-
Calopterygidae																		
Calopteryx sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hetaerina sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COLEOPTERA																		
Gyrinidae																		
Gyrinus sp.	-	-	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-
Gyretes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	P	-	-
Dineutus sp.	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
Libellulidae													
Neurocordulia sp.	P	-	-	-	-	-	-	-	-	-	-	-	-
Macromia sp.	P	-	-	-	-	-	P	-	P	-	-	P	-
Erythemis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Pachydiplax sp.	-	-	-	-	-	-	-	-	-	-	-	-	C
Orthemis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Epicordulia sp.	-	-	-	-	-	-	-	-	-	-	-	P	-
Sympetrum sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Coenagrionidae													
Coenagrion sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Enallagma sp.	P	-	-	-	-	-	-	-	-	-	-	-	P
Ischnura sp.	P	-	-	-	-	-	-	-	P	-	-	-	C
Argia sp.	-	-	-	-	-	-	-	-	-	-	-	P	-
Undetermined sp.	P	-	-	-	P	-	-	-	P	-	-	-	-
Calopterygidae													
Calopteryx sp.	P	-	-	P	P	-	P	-	-	-	-	-	-
Hetaerina sp.	P	-	-	-	P	-	-	-	-	-	-	-	-
COLEOPTERA													
Gyrinidae													
Gyrinus sp.	P	-	-	-	-	-	-	-	-	-	P	-	-
Gyretes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Dineutus sp.	-	-	-	-	-	-	P	-	-	P	-	P	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Haliplidae																				
Peltodytes sp.	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dytiscidae																				
Hydroporus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Matus sp.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-
Copelatus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Celina sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Derovatellus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydaticus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Noteridae																				
Suphisellus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrophilidae																				
Hydrochus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tropisternus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Berosus sp.	P	-	-	P	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-
Hydrobius sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenidae																				
Ectopria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Haliplidae																		
Peltodytes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Dytiscidae																		
Hydroporus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Matus sp.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Copelatus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Celina sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Derovatellus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydaticus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Noteridae																		
Suphisellus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Hydrophilidae																		
Hydrochus sp.	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tropisternus sp.	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
Berosus sp.	-	P	-	-	-	-	-	-	-	P	-	-	-	-	P	-	-	-
Hydrobius sp.	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
Psephenidae																		
Ectopria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
Haliplidae													
Peltodytes sp.	-	-	-	P	-	-	-	-	P	-	-	-	-
Dytiscidae													
Hydroporus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Matus sp.	-	-	-	-	-	-	-	-	-	-	-	P	-
Copelatus sp.	-	-	-	-	-	-	-	P	-	-	-	-	-
Celina sp.	-	-	-	-	-	-	-	-	-	-	-	-	P
Derovatellus sp.	-	-	-	-	-	-	-	-	-	-	-	-	P
Hydaticus sp.	-	-	-	-	-	-	-	P	-	-	-	-	-
Noteridae													
Suphisellus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrophilidae													
Hydrochus sp.	-	-	-	-	-	-	-	-	-	-	-	-	P
Tropisternus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Berosus sp.	-	-	-	-	-	-	-	-	P	-	-	P	P
Hydrobius sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenidae													
Ectopria sp.	P	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Elmidae																				
Stenelmis sp.	-	-	-	P	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
Ancyronyx variegatus	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-
A. sp.	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-
Dubiraphia vittata	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D. sp.	-	-	A	-	-	-	-	P	-	P	-	-	P	-	-	-	-	-	P	-
Macronychus glabratus	-	-	P	-	-	-	-	-	-	-	-	-	-	P	-	-	-	P	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysomelidae																				
Donacia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MEGALOPTERA																				
Sialidae																				
Sialis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corydalidae																				
Corydalus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HEMIPTERA																				
Corixidae																				
Sigara sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-
Mesoveliidae																				
Mesovelia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Elmidae																		
Stenelmis sp.	-	P	-	-	-	-	-	-	P	P	P	P	-	P	-	-	P	P
Ancyronyx variegatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dubiraphia vittata	-	-	-	-	-	-	-	P	-	-	-	-	-	-	P	-	-	-
D. sp.	P	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-
Macronychus glabratus	-	-	-	-	-	-	-	-	-	-	P	-	-	-	P	-	-	-
Undetermined sp.	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysomelidae																		
Donacia sp.	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
MEGALOPTERA																		
Sialidae																		
Sialis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corydalidae																		
Corydalus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HEMIPTERA																		
Corixidae																		
Sigara sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	P	-
Mesoveliidae																		
Mesovelia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
Elmidae													
Stenelmis sp.	C	-	-	-	-	-	-	-	C	-	C	-	-
Ancyronyx variegatus	-	-	-	-	-	-	-	-	-	-	P	-	-
A. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Dubiraphia vittata	-	-	-	-	-	-	-	-	-	-	-	-	-
D. sp.	-	-	P	-	-	-	-	-	P	-	P	-	-
Macronychus glabratus	P	-	-	-	-	-	-	-	P	-	P	-	P
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysomelidae													
Donacia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
MEGALOPTERA													
Sialidae													
Sialis sp.	-	-	-	-	-	-	-	-	-	-	-	P	-
Corydalidae													
Corydalus sp.	P	-	-	-	P	-	-	P	-	-	P	-	-
HEMIPTERA													
Corixidae													
Sigara sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	P	P	-	-	-
Mesoveliidae													
Mesovelia sp.	-	-	-	-	-	-	-	-	P	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Gerridae																				
Gerris sp.	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-
Rheumatobates sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trepobates sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Veliidae																				
Rhagovelia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LEPIDOPTERA																				
Pyralididae																				
Nymphula sp.	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA																				
Undetermined sp.	-	-	P	-	-	-	-	-	-	-	-	-	P	-	P	-	-	P	-	-
Naididae																				
Nais sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stylaria sp.	-	C	A	C	-	A	A	C	-	P	-	-	-	-	-	-	P	C	P	-
Pristina breviseta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-
P. sp.	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	P	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Tubificidae																				
Aulodrilus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	A	-	C	-	P	-	A	-	-	P	-	-	A	-	C	-	-	-	-	P
Lumbriculidae																				
Undetermined sp.	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Gerridae																		
Gerris sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rheumatobates sp.	P	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-
Trepobates sp.	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Veliidae																		
Rhagovelia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LEPIDOPTERA																		
Pyralididae																		
Nymphula sp.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
OLIGOCHAETA																		
Undetermined sp.																		
Naididae																		
Nais sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stylaria sp.	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pristina breviseta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tubificidae																		
Aulodrilus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Undetermined sp.	P	-	-	C	-	-	-	C	-	C	-	-	-	-	P	-	-	-
Lumbriculidae																		
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
Gerridae													
Gerris sp.	-	-	-	-	-	-	-	-	-	-	-	-	P
Rheumatobates sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Trepobates sp.	-	-	-	-	-	-	-	-	P	-	-	-	-
Veliidae													
Rhagovelia sp.	-	-	P	-	-	-	-	-	-	-	-	-	-
LEPIDOPTERA													
Pyralididae													
Nymphula sp.	-	-	-	-	-	-	-	-	P	-	-	-	-
OLIGOCHAETA													
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Naididae													
Nais sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Stylaria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Pristina breviseta	-	-	-	-	-	-	-	-	-	-	-	-	-
P. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	P	-	-	A	P	-	-	-	-
Tubificidae													
Aulodrilus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	P	-	P	-	-	-	C	-	P	-	-	-	P
Lumbriculidae													
Undetermined sp.	-	-	-	P	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
CRUSTACEA																				
Talitridae																				
Hyalella azteca	C	C	C	C	C	P	C	A	A	C	P	A	P	A	A	A	P	A	C	A
Gammaridae																				
Gammarus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Astacidae																				
Undetermined sp.	-	-	-	P	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-
Palaemoniidae																				
Palaemonetes paludosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asellidae																				
Asellus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PELECYPODA																				
Unionidae																				
Villosa sp.	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphaeriidae																				
Sphaerium sp.	C	-	P	P	-	-	-	P	P	P	-	-	-	P	C	-	-	-	-	-
Eupera sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pisidium sp.	C	-	C	-	-	-	C	-	-	C	-	-	-	-	C	-	-	-	P	-
Musculium sp.	-	-	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Undetermined sp.	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
CRUSTACEA																		
Talitridae																		
Hyalella azteca	A	A	C	P	-	-	-	C	C	A	C	-	-	-	C	-	-	P
Gammaridae																		
Gammarus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Astacidae																		
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palaemoniidae																		
Palaemonetes paludosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asellidae																		
Asellus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PELECYPODA																		
Unionidae																		
Villosa sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphaeriidae																		
Sphaerium sp.	-	-	-	-	-	-	-	C	-	-	P	-	-	-	-	-	-	-
Eupera sp.	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-	-
Pisidium sp.	-	-	P	C	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Musculium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
CRUSTACEA													
Talitridae													
Hyalella azteca	-	-	-	-	-	-	-	-	-	-	-	-	-
Gammaridae													
Gammarus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Astacidae													
Undetermined sp.	-	-	P	C	P	-	-	-	P	-	-	P	P
Palaemoniidae													
Palaemonetes paludosus	P	-	-	-	-	-	-	-	-	-	-	-	-
Asellidae													
Asellus sp.	-	-	-	-	P	-	-	-	-	-	-	-	-
PELECYPODA													
Unionidae													
Villosa sp.	-	-	-	-	-	-	-	-	-	-	-	P	-
Sphaeriidae													
Sphaerium sp.	P	-	-	P	C	-	P	-	P	-	-	P	-
Eupera sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Pisidium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Musculium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
GASTROPODA																				
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viviparidae																				
Campeloma sp.	-	-	C	-	P	-	P	-	-	C	-	-	-	-	C	-	-	-	-	-
Bulimidae																				
Clappia sp.	C	C	C	C	-	-	C	C	C	P	-	P	P	C	C	P	-	-	P	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ancylidae																				
Ferrissia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	P	-
Pleuroceridae																				
Goniobasis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lymnaeidae																				
Pseudosuccinea sp.	P	P	-	-	-	-	-	C	P	-	-	-	-	P	-	-	-	-	-	-
Planorbidae																				
Gyraulus sp.	P	-	P	C	-	-	-	A	A	P	-	-	-	A	P	-	P	P	P	-
Helisoma sp.	P	-	P	P	-	-	P	C	P	P	-	-	-	P	P	-	-	-	-	-
Physidae																				
Physa sp.	P	P	C	C	P	P	C	A	A	P	P	P	P	A	C	C	P	C	C	P
NEMERTEA																				
Prostoma rubrum	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
GASTROPODA																		
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Viviparidae																		
Campeloma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bulimidae																		
Clappia sp.	P	-	-	-	-	-	-	P	-	P	P	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Ancylidae																		
Ferrissia sp.	-	-	P	-	-	-	-	P	-	P	P	-	-	-	-	-	-	-
Pleuroceridae																		
Goniobasis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lymnaeidae																		
Pseudosuccinea sp.	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Planorbidae																		
Gyraulus sp.	-	-	-	P	-	-	-	P	-	P	P	-	-	-	P	-	-	C
Helisoma sp.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Physidae																		
Physa sp.	A	A	C	A	-	-	-	C	C	P	A	P	-	-	C	-	P	P
NEMERTEA																		
Prostoma rubrum	-	C	-	-	-	-	-	-	-	P	-	-	-	-	-	-	P	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
GASTROPODA													
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Viviparidae													
Campeloma sp.	P	-	-	-	-	-	-	-	-	-	-	C	-
Bulimidae													
Clappia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ancylidae													
Ferrissia sp.	-	-	-	-	-	-	P	-	-	-	-	P	P
Pleuroceridae													
Goniobasis sp.	-	-	-	-	-	-	-	-	-	-	-	P	-
Lymnaeidae													
Pseudosuccinea sp.	-	-	-	P	-	-	-	-	-	-	-	P	-
Planorbidae													
Gyraulus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Helisoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Physidae													
Physa sp.	-	-	-	-	-	-	P	-	-	P	-	-	C
NEMERTEA													
Prostoma rubrum	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
NEMATODA																				
Undetermined sp.	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	P
HIRUDINEA																				
Undetermined sp.	C	P	P	P	-	-	P	-	-	P	-	P	-	-	C	P	-	P	-	-
TURBELLARIA																				
Planariidae																				
Undetermined sp.	-	C	P	P	P	P	P	-	-	-	-	-	-	-	-	P	-	-	-	P
HYDRACARINA																				
Undetermined sp.	-	P	-	-	-	-	-	-	P	-	-	-	P	-	-	-	-	-	P	-
BRYOZOA																				
Urnatella gracilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PISCES																				
Ictaluridae																				
Ictalurus platycephalus	-	-	P	P	-	-	P	-	-	P	-	-	-	-	-	-	-	-	P	-
Noturus leptacanthus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Centrarchidae																				
Lepomis microlophus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
L. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Micropterus salmoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
NEMATODA																		
Undetermined sp.	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HIRUDINEA																		
Undetermined sp.	-	P	-	-	-	-	-	P	P	P	P	P	-	-	-	-	-	-
TURBELLARIA																		
Planariidae																		
Undetermined sp.	-	P	-	P	-	-	-	-	-	-	P	C	-	-	-	-	P	-
HYDRACARINA																		
Undetermined sp.	P	-	-	-	-	-	-	-	-	C	C	-	-	-	-	-	-	-
BRYOZOA																		
Urnatella gracilis	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
PISCES																		
Ictaluridae																		
Ictalurus platycephalus	-	P	-	-	-	-	-	-	P	P	P	-	-	-	P	-	-	-
Noturus leptacanthus	-	-	-	-	-	-	-	P	-	-	P	-	-	-	-	-	-	-
Centrarchidae																		
Lepomis microlophus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
L. sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Micropterus salmoides	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
NEMATODA													
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
HIRUDINEA													
Undetermined sp.	-	-	-	P	P	-	-	-	-	-	-	-	-
TURBELLARIA													
Planariidae													
Undetermined sp.	-	-	-	-	-	-	P	-	-	-	-	-	-
HYDRACARINA													
Undetermined sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
BRYOZOA													
Urnatella gracilis	-	-	-	-	-	-	-	-	-	-	-	-	-
PISCES													
Ictaluridae													
Ictalurus platycephalus	-	-	-	-	-	-	-	-	-	-	-	P	-
Noturus leptacanthus	-	-	-	-	-	-	-	-	-	-	P	-	-
Centrarchidae													
Lepomis microlophus	-	-	-	-	-	-	-	-	P	-	-	-	-
L. sp.	-	-	-	-	-	-	-	-	-	-	-	-	P
Micropterus salmoides	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-73		S-51		S-75		S-53		S-76		S-78		S-79		S-81		S-58		S-82	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Elassoma zonatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Enneacanthus chaetodon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aphredoderidae																				
Aphredoderus sayanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Percidae																				
Etheostoma nigrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anguillidae																				
Anguilla rostrata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Poeceliidae																				
Gambusia affinis	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AMPHIBIA																				
Plethodontidae																				
Desmognathus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	S-84		S-86		S-87		S-88		S-89		S-47		S-66		S-68		S-69	
	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E
Elassoma zonatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Enneacanthus chaetodon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Sphredoderidae																		
Aphredoderus sayanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Percidae																		
Etheostoma nigrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anguillidae																		
Anguilla rostrata	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-	-	P	P
Poeceliidae																		
Gambusia affinis	-	-	-	-	-	-	-	-	-	C	-	-	-	-	P	-	-	-
AMPHIBIA																		
Plethodontidae																		
Desmognathus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

	LHC-31	LHC-33	KC-21	KC-22	KC-24	HC-35	BC-5	BC-6	SC-10	SC-11	LSC-94	LTR-43	LTR-45
Elassoma zonatum	-	-	-	-	-	-	-	-	-	-	-	-	-
Enneacanthus chaetodon	-	-	-	-	-	-	-	-	-	-	-	-	-
Aphredoderidae													
Aphredoderus sayanus	-	-	-	-	-	-	-	-	-	-	-	P	-
Percidae													
Etheostoma nigrum	-	-	-	-	-	-	-	-	-	-	P	P	-
Anguillidae													
Anguilla rostrata	-	-	-	-	-	-	-	-	-	-	-	-	-
Poeceliidae													
Gambusia affinis	-	-	-	-	-	-	P	-	-	-	P	P	-
AMPHIBIA													
Plethodontidae													
Desmognathus sp.	-	-	P	-	-	-	-	-	-	-	-	-	-

TABLE C-I-II

PLANKTON COUNTS (cells/mℓ) FROM THE MIDDLE SAVANNAH RIVER
(August 1-4, 1970)

	73	73	51	51	75	75	53	53	76	76
Coccoid Blue Greens	0	0	0	0	0	0	0	0	0	33
Filamentous Blue Greens	0	0	0	0	0	0	0	0	0	0
Coccoid Greens	33	0	0	0	0	0	33	0	0	0
Filamentous Greens	0	0	0	0	33	0	0	0	0	0
Green Flagellates	0	0	0	0	0	0	0	0	0	0
Diatoms										
Centrics	0	66	33	33	33	0	33	33	33	33
Pennates	0	0	33	0	33	0	33	0	66	0
MEAN TOTAL ALGAE PER STATION	33	66	66	33	99	0	99	33	99	66
	50		50		50		66		82	

TABLE C-I-II(continued)

PLANKTON COUNTS (cells/mℓ) FROM THE MIDDLE SAVANNAH RIVER (August 1-4, 1970)

	78	78	81	81	58	58	82	83	83	84
Coccoid Blue Greens	0	0	0	0	0	0	0	0	0	0
Filamentous Blue Greens	0	0	0	0	0	33	33	0	0	0
Coccoid Greens	0	0	0	0	0	0	33	0	0	0
Filamentous Greens	0	0	0	0	0	0	0	0	0	33
Green Flagellates	0	0	0	0	0	0	0	0	0	0
Diatoms										
Centrics	99	66	264	132	33	66	66	132	66	66
Pennates	33	66	33	33	66	33	99	33	99	33
MEAN TOTAL ALGAE PER STATION	132	132	297	165	99	132	231	165	165	66
	132		231		116		231	165		132

TABLE C-I-II (continued)

PLANKTON COUNTS (cells/mℓ) FROM THE MIDDLE SAVANNAH RIVER
(August 1-4, 1970)

	85	85	86	86	87	87	88	89	89	90	91	91
Coccoid Blue Greens	0	0	66	33	0	0	0	0	0	0	33	0
Filamentous Blue Greens	0	0	0	0	0	0	0	0	0	0	33	0
Coccoid Greens	0	0	0	33	0	0	0	0	33	33	33	0
Filamentous Greens	0	0	0	33	66	0	0	0	0	0	0	0
Green Flagellates	0	0	0	0	0	0	0	0	0	0	0	0
Diatoms												
Centrics	33	99	99	99	132	132	165	165	33	66	132	99
Pennates	33	33	33	33	66	132	66	0	33	66	0	0
	66	132	198	231	264	264	231	165	99	165	231	99
MEAN TOTAL ALGAE PER STATION	99		214		264		231	132		165	165	

TABLE C-I-III

ATTACHED ALGAE PER SQUARE MILLIMETER (mm^2) OF SLIDE SURFACE FROM
SAVANNAH RIVER STATIONS
(August 1, 1970 - September 1, 1970)

	73	74	75	52	53	79	81	58	82	85	87	89
Coccoid Blue Greens	0	6	48	0	0	0	4	0	0	0	0	0
Filamentous Blue Greens	0	42	485	26	0	12	11	29	5	2	72	36
Coccoid Green	0	0	20	2	65	71	13	0	2	3	0	4
Filamentous Green	0	0	5	29	33	149	13	6	18	0	25	55
Green Flagellates	0	0	0	0	0	0	0	0	0	0	0	0
Other Pigmented Flagellates	2	2	3	11	7	3	15	6	57	13	8	12
Diatoms												
Centrics	0	9	2	2	1	5	37	3	4	14	4	6
Pennates	565	401	737	2304	915	770	698	1556	616	837	84	139
TOTAL ALGAE[1]	565	458	1296	2364	1014	1008	791	1594	645	855	186	239

[1] Does not include pigmented flagellates.

TABLE C-I-IV

PLANKTON COUNTS (cells/mℓ) FROM LOWER THREE RUNS CREEK AND FROM SAVANNAH RIVER IN VICINITY OF LOWER THREE RUNS CREEK (July 28, 1970 - July 30, 1970)

	43	43	43	45	45	45	47	47	47	68	68	68	71	71	71
Coccoid Blue Greens	0	0	0	0	0	0	0	0	66	33	0	33	0	33	0
Filamentous Blue Greens	0	0	0	33	66	231	0	33	0	0	0	0	33	0	0
Coccoid Green	0	0	0	0	0	0	0	33	0	33	0	66	33	33	0
Filamentous Green	0	0	0	0	0	33	66	0	66	33	0	66	0	0	0
Green Flagellates	0	0	0	0	0	0	0	33	0	0	0	0	0	33	0
Other Pigmented Flagellates	0	0	0	0	0	0	0	0	33	0	0	0	0	0	0
Diatoms															
Centrics	66	0	33	66	66	66	99	132	132	99	99	66	132	165	99
Pennates	33	33	66	99	66	66	33	99	66	33	66	33	33	33	99
TOTAL ALGAE	99	33	99	198	198	396	198	330	363	231	165	264	231	297	198
		77			264			297			220			242	

TABLE C-I-V

QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

	STATIONS												
FILAMENTOUS BLUE GREENS	BC-6	HC-35	LHC-31	LHC-33	KC-21	KC-22	KC-24	SC-10	LSC-94	S-47A	S-71A	S-72A	S-76A
Oscillatoria (*agardhii*)	P	C	-	C	-	A	-	-	P	-	P	-	C
O. (*ornata*)	C	-	-	-	-	-	-	-	-	-	-	-	-
O. (*pseudogeminata*)	-	A	A	-	-	A	P	P	P	P	-	-	C
O. (*chlorina*)	-	-	-	-	-	P	-	P	-	-	-	-	-
O. (*amphibia*)	-	-	-	-	-	-	P	-	-	-	-	-	-
O. (*splendida*)	-	-	-	-	-	-	-	-	C	-	P	-	-
O. sp.	-	-	-	-	P	P	-	-	P	-	-	-	-
Lyngbya (*versicolor*)	-	-	P	-	-	-	-	-	-	-	-	-	-
L. (*digueti*)	-	-	-	-	-	P	-	-	-	-	-	-	-
Anabaena *constricta*	-	-	P	-	-	P	P	P	P	P	C	-	-
Anabaena sp.	-	-	-	-	-	-	-	-	P	-	-	-	-
Spirulina (*nordstedtii*)	-	-	-	-	-	-	-	-	-	-	-	-	P

TABLE C-I-V (continued)

QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

	STATIONS												
COCCOID GREEN ALGAE	BC-6	HC-35	LHC-31	LHC-33	KC-21	KC-22	KC-24	SC-10	LSC-94	S-47A	S-71A	S-72A	S-76A
Cosmarium (portianum)	-	-	P	-	-	P	-	-	P	-	-	-	-
C. botrytis	-	-	P	P	-	P	-	P	P	-	-	-	-
Scenedesmus bijuga	-	-	P	P	-	-	-	P	-	-	-	-	P
S. quadricauda	-	-	-	P	-	-	-	P	-	-	-	-	P
S. dimorphus	-	-	-	P	-	-	-	-	-	-	-	-	P
S. sp.	-	-	-	-	-	-	-	-	-	P	-	-	-
Closterium sp.	-	-	P	-	A	C	P	P	P	-	-	-	-
C. moniliferum	-	-	-	-	-	-	-	-	-	-	C	-	-
Pediastrum tetras	-	-	P	-	-	-	-	-	-	-	-	-	P
Ankistrodesmus falcatus	-	-	P	-	-	-	-	-	-	-	-	-	P
Staurastrum (punctulatum)	-	-	-	P	-	-	-	-	-	-	-	-	-
Coelastrum microporum	-	-	-	P	-	-	-	-	-	-	-	-	P
Batrachospermum vagum	-	-	A	-	-	-	-	-	C	-	-	-	-
Chlorella sp.	-	-	-	-	-	-	-	-	-	-	-	-	P
Penium (desmid)	-	-	-	-	-	-	P	P	-	-	-	-	-

TABLE C-I-V (continued)

QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

	STATIONS												
FILAMENTOUS GREEN ALGAE	BC-6	HC-35	LHC-31	LHC-33	KC-21	KC-22	KC-24	SC-10	LSC-94	S-47A	S-71A	S-72A	S-76A
Cladophora *glomerata*	A	-	-	-	-	A	-	-	C	-	-	-	-
Spirogyra *majuscula*	-	-	P	-	-	-	A	-	A	-	-	A	-
S. *fluviatilis*	-	-	-	-	-	-	-	-	A	-	-	-	-
S. sp.	-	-	-	-	-	-	-	-	-	P	C	-	-
Mougeotia sp.	-	-	P	-	-	-	-	-	P	-	-	A	-
Oedogonium *grande*	-	-	-	-	-	-	A	-	-	-	-	-	-
O. *surecium*	-	-	-	-	-	-	-	-	P	-	-	-	-
Vauchevia sp.	-	-	-	-	-	-	-	-	-	A	-	-	-
Zygnema sp.	-	-	-	-	-	-	-	-	-	-	-	P	-
Ulothrix (*tenerrima*)	-	-	-	-	-	-	-	-	-	-	-	-	P

TABLE C-I-V (continued)

QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

	STATIONS												
GREEN FLAGELLATES	BC-6	HC-35	LHC-31	LHC-33	KC-21	KC-22	KC-24	SC-10	LSC-94	S-47A	S-71A	S-72A	S-76A
Trachelomonas sp.	-	P	P	-	-	-	P	-	-	-	-	-	-
T. crebea	-	-	-	P	-	-	-	-	-	-	-	-	-
OTHER PIGMENTED FLAGELLATES													
Dinoflagellate shells	-	P	-	-	-	-	-	-	-	-	-	-	-
Shells present	-	-	-	P	-	-	-	-	-	-	-	-	-

TABLE C-I-V (continued)

QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

	STATIONS												
PENNATES	BC-6	HC-35	LHC-31	LHC-33	KC-21	KC-22	KC-24	SC-10	LSC-94	S-47A	S-71A	S-72A	S-76A
Navicula	A	P	C	-	A	A	P	A	C	P	C	P	P
Synedra (pulchella)	-	-	P	-	-	-	-	-	-	-	-	-	-
S. sp.	-	-	-	-	-	-	P	-	P	P	C	P	P
Tabellaria fenestrata	-	-	P	-	-	-	-	-	P	-	P	-	-
T. floculosa	-	-	P	P	-	-	P	-	-	-	P	-	-
T. sp.	-	-	-	-	-	P	-	-	P	P	-	-	-
Nitzschia acicularis	-	-	P	-	-	-	-	-	P	-	-	-	-
N. linearis	-	-	-	-	-	-	-	-	P	-	-	-	-
N. sp.	-	-	-	-	-	-	-	-	-	P	P	-	-
Fragillaria sp.	-	-	-	-	-	P	-	-	-	-	-	-	-
Surirella sp.	-	-	-	-	-	P	-	P	-	-	-	-	-
Gomphonema sp.	-	-	-	-	-	-	P	-	-	-	-	-	-
Cocconeis shell	-	-	-	-	-	-	-	-	-	P	-	-	-
Cocconeis sp.	-	-	-	-	-	-	-	-	P	-	P	-	-
Cymbella (prostrata)	-	-	-	-	-	-	-	-	P	-	-	-	P
Cymbella shell	-	-	-	-	-	-	-	-	-	P	-	-	-
Stauroneis shell	-	-	-	-	-	-	-	-	-	P	-	-	-
Gyrosigma attenuatum	-	-	-	-	-	-	-	-	-	-	C	-	-
Shells	-	-	-	P	-	-	-	-	-	-	-	-	-

TABLE C-I-V (continued)

QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

	STATIONS												
CENTRICS	BC-6	HC-35	LHC-31	LHC-33	KC-21	KC-22	KC-24	SC-10	LSC-94	S-47A	S-71A	S-72A	S-76A
Melosira (*herzogii*)	-	-	-	-	-	-	-	A	-	-	-	-	-
M. (*varians*)	-	-	-	-	-	-	-	-	-	P	-	-	-
M. sp.	-	-	-	-	-	-	-	-	-	-	C	-	-
Cyclotella shell	-	-	-	-	-	-	-	-	-	P	-	-	-

TABLE C-I-VI

STANDING CROP AND DIVERSITY OF MACROINVERTEBRATES COLLECTED WITH ARTIFICIAL SUBSTRATE SAMPLERS FROM THE SAVANNAH RIVER

STATION	NUMBER SPECIES	NUMBER IND.	INDEX OF DIVERSITY	EQUITABILITY COEFFICIENT ("E")
S-73A	20	73	3.48	0.80
S-73A	14	62	3.15	0.93
S-73E	14	26	3.27	1.00
S-73E	12	85	2.86	0.83
MEAN		62	3.19	0.89
S-51A	16	70	3.32	0.88
S-51A	20	233	2.83	0.50
S-51E	17	121	2.83	0.59
S-51E	11	88	2.25	0.54
MEAN		128	2.81	0.63
S-75A	23	690	3.23	0.56
S-75A	20	379	3.04	0.55
S-75E	18	144	2.75	0.50
S-75E	9	75	2.31	0.78
MEAN		322	2.83	0.60
S-53A	33	455	3.90	0.67
S-53A	20	185	3.36	0.75
S-53E	17	143	3.14	0.76
S-53E	15	153	2.98	0.73
MEAN		234	3.34	0.73
S-76E	19	122	3.30	0.74
S-76E	21	116	3.31	0.67
MEAN		119	3.30	0.70
S-78A	14	35	2.10	0.43
S-78A	11	38	2.53	0.73
S-78E	16	103	2.82	0.62
S-78E	18	131	2.98	0.61
MEAN		77	2.61	0.60

See bottom of next page.

TABLE C-I-VI (continued)

STANDING CROP AND DIVERSITY OF MACROINVERTEBRATES COLLECTED WITH ARTIFICIAL SUBSTRATE SAMPLERS FROM THE SAVANNAH RIVER

(July 1, 1970 - September 8, 1970)

STATION	NUMBER SPECIES	NUMBER IND.	INDEX OF DIVERSITY	EQUITABILITY COEFFICIENT ("E")
S-58A	19	141	3.26	0.74
S-58A	14	158	2.86	0.71
S-58E	18	258	2.16	0.33
S-58E	15	154	2.36	0.47
MEAN		178	2.66	0.56
S-82A	20	141	3.14	0.65
S-82A	26	273	3.04	0.42
MEAN		207	3.09	0.53
S-84E	21	275	2.68	0.43
S-84E	22	253	2.90	0.45
MEAN		264	2.79	0.44
S-86A	10	67	2.39	0.70
S-86A	15	86	2.81	0.67
S-86E	15	240	1.39	0.20
S-86E	12	192	1.52	0.33
MEAN		146	2.03	0.48
S-87A	11	511	1.62	0.36
S-87A	12	286	1.79	0.42
MEAN		398	1.70	0.39
S-89A	15	386	2.34	0.47
S-89A	11	387	1.46	0.27
S-89E	21	487	2.62	0.38
S-89E	22	540	2.22	0.27
MEAN		450	2.16	0.35

Samplers at stations 558, 582, 584, 586, 587, and 589 exposed from August 1, 1970 - September 8, 1970.

TABLE C-I-VI (continued)

STANDING CROP AND DIVERSITY OF MACROINVERTEBRATES COLLECTED WITH ARTIFICIAL SUBSTRATE SAMPLERS FROM THE SAVANNAH RIVER

STATION	NUMBER SPECIES	NUMBER IND.	INDEX OF DIVERSITY	EQUITABILITY COEFFICIENT ("E")
S-66E	18	1526	2.65	0.50
S-66E	21	1458	3.03	0.52
MEAN		1492	2.84	0.51
S-69A	20	483	2.71	0.45
S-69A	30	789	2.53	0.27
S-69E	32	3653	2.50	0.25
S-69E	16	804	2.72	0.56
MEAN		1432	2.62	0.38